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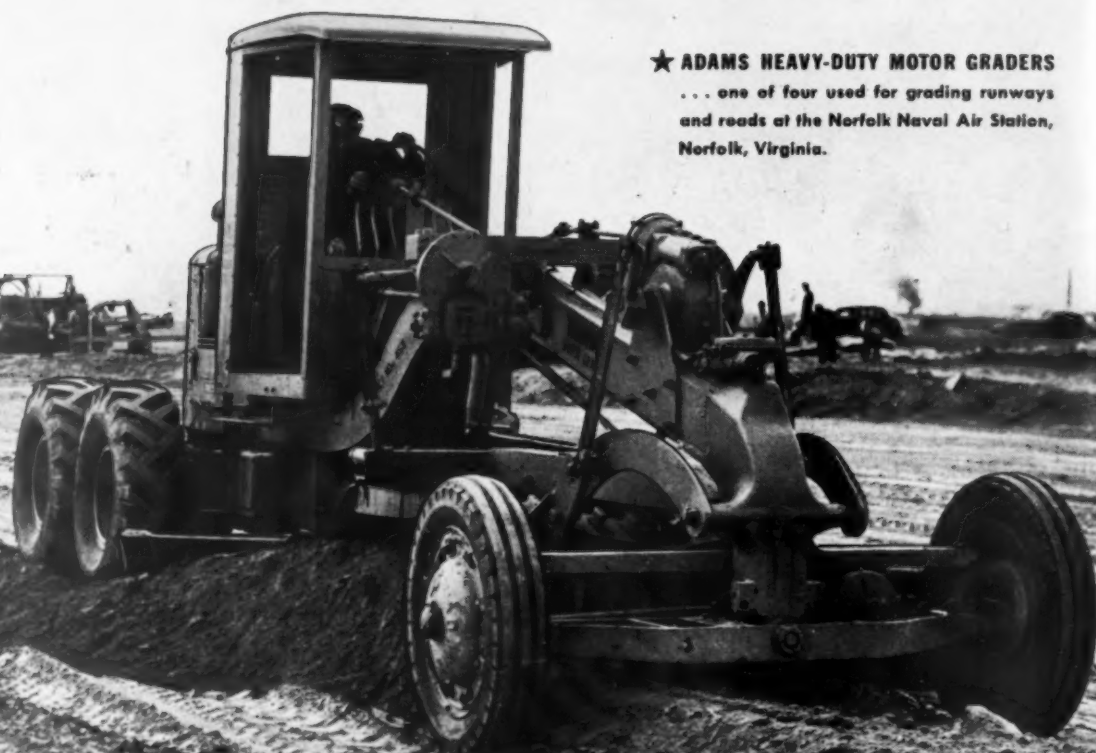
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Pennsylvania Turnpike



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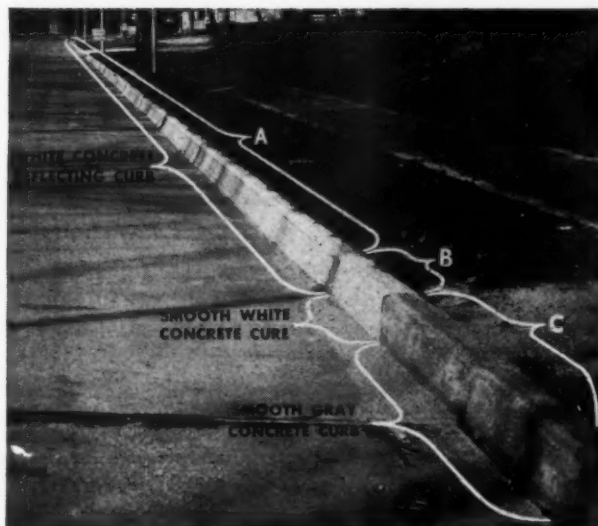
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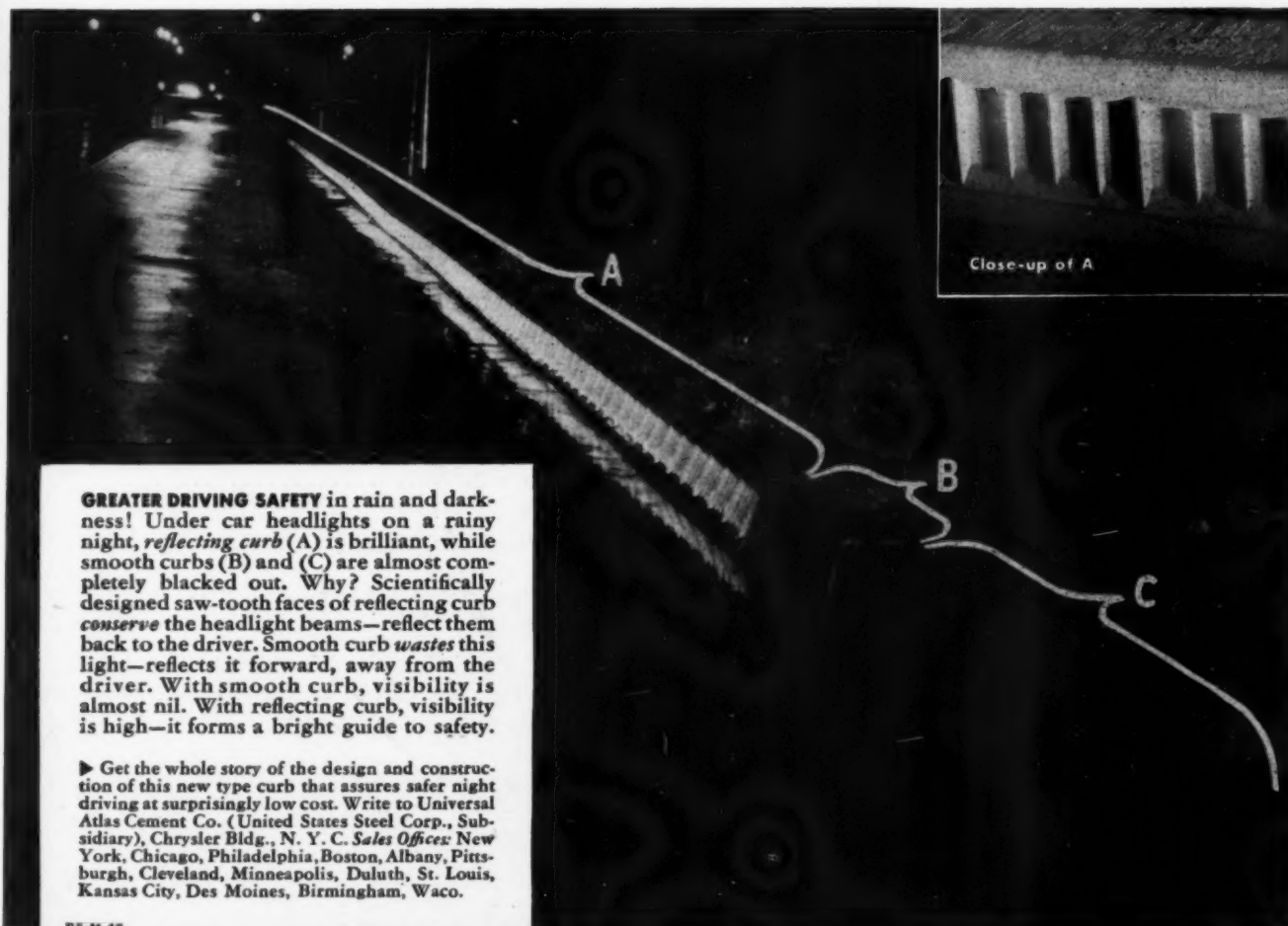
ROAD-BUILDING AND EARTH-MOVING EQUIPMENT

THE *A B C* OF SAFER NIGHT DRIVING

... Three types of curb at one location prove superiority of White Concrete Reflecting Curb



Reflecting white concrete curb (A), smooth white concrete curb (B), and smooth gray concrete curb (C), at one New Jersey location. In the night photograph below, note the great difference in visibility of the three curbs under car headlights on a rainy night. Contractor, Jannarone Contracting Co., Belleville, N. J.; Curb Contractor, Frapaul Construction Co., Inc., Hackensack, N. J.



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B5-M-10

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MADE WITH ATLAS WHITE CEMENT



ROADS and STREETS

With which have been merged GOOD ROADS and ENGINEERING & CONTRACTING

ESTABLISHED 1892

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ROADS and STREETS

Vol. 84, No. 5

May, 1941

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Extensive Research ON CONCRETE HIGHWAY PROJECT

*To Investigate Fundamental Principles and Factors
Developed by the Michigan Test Road*

By J. W. KUSHING

*Research Engineer
Michigan State Highway Department*

THE Michigan Test Road previously mentioned in the November, 1940, issue of *ROADS AND STREETS*, has been completed. The project was constructed under regular contract and construction procedure using the Michigan State Highway Department 1940 plans and specifications with necessary supplementals. The test road is located on M-115 between Farwell and M-66 and consists of 17.6 miles of 22-foot width concrete pavement. The project is essentially divided into two sections, one for a study of design principles, and the other for the study of durability factors particularly in regards to scaling. This article constitutes a summary pertaining to the construction of the test road and illustrates the principles and factors embodied in the project.



Subgrade Modulus Study. Equipment Set Up to Determine Bearing Value of Subgrade

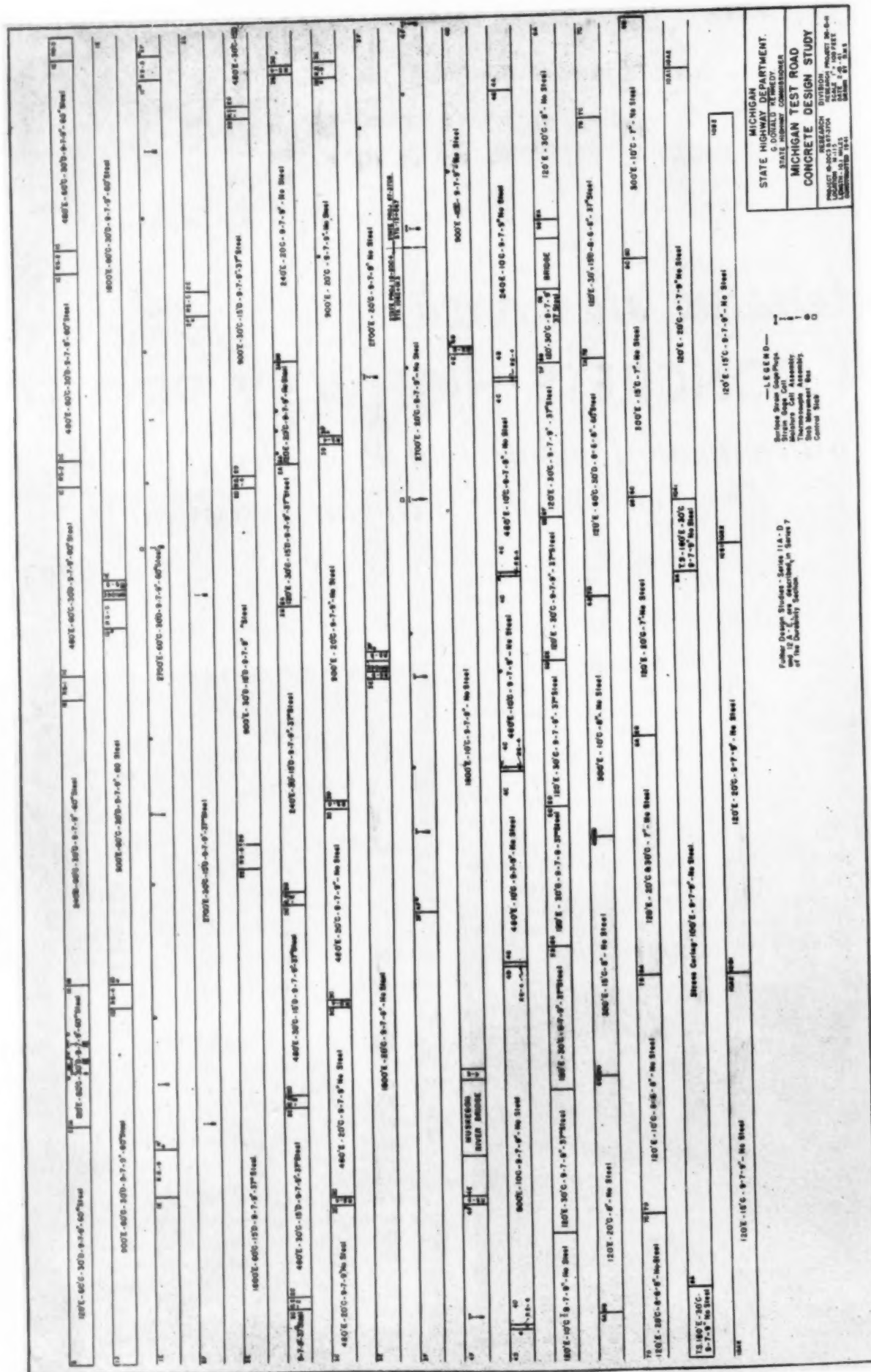
Design Study

The structural adequacy of a concrete pavement slab from the stand point of strength and permanency is influenced by the features of design which determine its continuity and dimensions. The features which were given study in the design section of the Michigan Test Road were joints, cross-section dimensions, and reinforcing.

Joints have been one of the most controversial subjects in the design of concrete pavements. Therefore, they were given considerable attention in the Michigan Test Road. Emphasis was placed upon joint spacing, expansion space and joint construction. Several different spacings of expansion joints from 120 feet to 2700 feet were used for various cross-sections and various amounts of reinforcing steels. Correspondingly, various spacings of contraction joints from 10 to 60-foot intervals were used.



Mechanical Handling of Concrete



Schematic Layout Showing Factors Embodied in Design Study



Expansion Joint Study. Method of Measuring Joint Opening

The proper spacing of joints will be determined by permissible maximum stress intensities induced by linear frictional restraint and flexural weight restraint. Various types of expansion and contraction joints were installed to evaluate load transfer and the preservation of mutual elevation slab ends. In this connection, a study of thickened slab ends at expansion joints, as well as the effectiveness of aggregate interlock at contraction joints will be studied. In this project a study of required expansion space for different spacings will also be made. In regard to the design of the pavement slab itself, thought has been given to the study of reduced thickness on prepared subgrades, and equivalent uniform thickness versus the balanced cross-section. In this respect, four different types of cross-sections were set up for study on this project; namely, 9 in.-7 in.-9 in. Michigan State Highway Department standard cross-section; 8 in. uniform, the approximate equivalent of 9 in.-7 in.-9 in., 8 in.-6 in.-8 in., a reduced cross-section which might be used on subgrades of sufficient supporting value; and 7 in. uniform the approximate equivalent of the 8 in.-6 in.-8 in. cross-section.

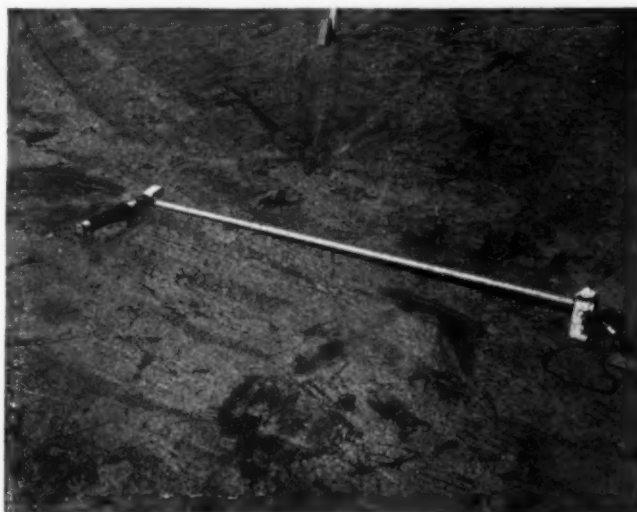


Slab Movement Study. Measuring Slab Movement

In planning the Michigan Test Road, it was felt that a study of reinforcing steel should be included because of the many unanswered questions concerning its use among which are: (1) the amount of reinforcing steel required, (2) economics of reinforced pavement versus unreinforced pavement with adequate jointing, and (3) the relation of plain uniform cross-section to reinforced "balanced" cross-section. To this end, sections were constructed using 9 in.-7 in.-9 in., 8 in. and 7 in. uniform cross-section using plain concrete, and reinforced concrete with 60 pounds per hundred square feet and 37 pounds per hundred square feet.

For proper appraisal of the structural efficiency of the elements of design considered in this project, periodic visual examinations together with measurement of displacements and physical conditions must be made.

Throughout the entire project, special measuring devices and reference points have been installed including: (1) electrical strain gauges for measuring stresses, (2) thermocouples for temperature studies, (3) moisture cells for determining moisture content of concrete and subgrade soil, (4) reference monuments for detecting slab movement, (5) reference points for measuring changes in joint width, (6) elevation points for meas-



Electric Strain Meter Assembly For Measuring Stresses in Pavement Slab

uring changes in joints, (7) meteorological station for obtaining complete record of weather conditions, and (8) a traffic counter for recording vehicle movement over the test road.

Incidental with the construction of the Test Road, additional studies have been made which are of particular interest to the Michigan State Highway Department and pertinent to the improvement of concrete pavement construction. They are: stress curing of concrete, mechanical spreading of concrete, and the use of various types of joint sealing materials.

The design section of the Michigan Test Road coincides in a general way with the Public Roads Administration's plans and procedure for construction of experimental roads which were submitted to various state highway organizations in 1940. The purpose of this experimental work is to study the desired spacing of transverse expansion joints in concrete pavements and the amount of expansion space required per unit pavement length, and to study the efficiency of dummy contraction joints with and without dowels or other devices for the transfer of load.

A more comprehensive description of the design



Slab Movement Study. Thermocouples and Moisture Cells for Determining Changes in Temperature and Moisture Content

phase of the Michigan Test Road will be found in the 1940 proceedings of the Highway Research Board.

Durability Study

The durability section was constructed to make observations under service, of factors which had been determined by other investigations or in laboratory studies of the Research Division, that might be effective in the prevention of scaling. The purpose of this pavement was not only to make observations under service conditions but to afford a field laboratory to obtain accelerated action of chloride salts or ice on concrete pavements and the study of resultant action. The durability study project entails a length of approximately 7.7 miles. The location is ideal from a standpoint of average weather conditions in Michigan and the length is sufficient to reduce the variables of construction to a minimum for each factor investigated. The supplemental specifications covered details for all variables unusual to Michigan State Highway Department specifications. They included cements, admixtures, mix designs and methods of construction which preliminary laboratory studies indicated to possess characteristics favorable to the prevention of scaling.

The cements used included two brands of regular portland cement as normally used in the construction of concrete pavements in Michigan. Admixtures included the use of certain proprietary materials known as Plastiment, Pozzoloth, Orvus, and Vinsol Resin. Natural cement was also included, which was ground with and without the use of calcium stearate. Mix designs included the regular proportioning as determined by the material specifications and the mortar void design method of the Michigan State Highway Department, as well as the addition of fines supplementing the fine aggregates. These fines were added to increase the density



Finishing and Curing Studies. Study Included Ponding, Wetted Earth, Wetted Straw, Wetted Burlap, Calcium Chloride, and Water-Proof Membranes

and workability of the mix and a possible resultant reduction in scaling. Short sections were included to determine the relation of scaling to methods of curing.

The methods for finishing and curing of concrete studies on the project included the standard methods set out in the specifications of the Michigan State Highway Department.

The curing specifications include: (1) wetted earth, (2) wetted straw or hay, (3) ponding, (4) wetted burlap, (5) asphalt emulsion and (6) calcium chloride.

In addition to these methods, curing by cut-back asphalt was used on a section for study. The study of the curing methods was incorporated into the project only for the purpose of determining the relative resistance to scaling of the same concrete under various curing methods.

The final finishing operation specified in the Michigan State Highway Department standard specifications requires the use of a burlap drag.

In most cases, this method produces a satisfactory non-skid surface, but it is observed, under certain conditions, that an excess amount of fine material still remains upon the surface. All studies of scaling seem to indicate that this thin layer of material is the first to be displaced. Brooming the concrete with stiff brooms as a final finishing operation has been used by some highway engineers to reduce the amount of fine superficial material. However, some engineers have contended that this method provided grooves for the concentration of salt solutions and a resultant unsatisfactory condition of aggravated scaling. Therefore, it was felt that comparative study should be made of these two methods and obtain comparative data upon the two methods. Brooming was also included on certain sections of bituminous curing, since in the past, these methods of curing provided a rather slippery pavement for some time after construction, and it was hoped that a trial section of brooming would show how to overcome this difficulty if bituminous curing were allowed in the standard specifications.

The research information secured on the durability project divides itself into three groups: First, information obtained during construction; second, observations under service; and third, special scaling study.

Construction Observations and Data.—Observations and data obtained during construction are very important in the later interpretation of findings. Consequently, the observers were admonished to follow instructions closely and impressed with the importance of precise, unbiased and accurate analyses, observations, and data. The information procured during this period consisted of the following items:

1. Soil surveys. Soil density and moisture content.
2. Meteorological observations, including:
 - a. Humidity
 - b. Temperature
 - c. Precipitation
 - d. Wind movement
 - e. Evaporation
3. Daily progress report including irregularities.
4. Moisture content and temperature of concrete on special sections of curing.
5. Placing of concrete pavement.
6. Mechanical analysis of concrete to determine relative segregation.
7. Special observations relative to final finishing methods and curing.

Observations in Service.—The relative value of the various factors may be prophesied by laboratory tests and observations during construction, but the ultimate conclusions must be determined by observations made under actual service conditions. Therefore, it is planned to make periodic visual examinations together with measurement of physical conditions as outlined in

Schematic Lay-Out Showing Various Factors Embodied in Durability Study



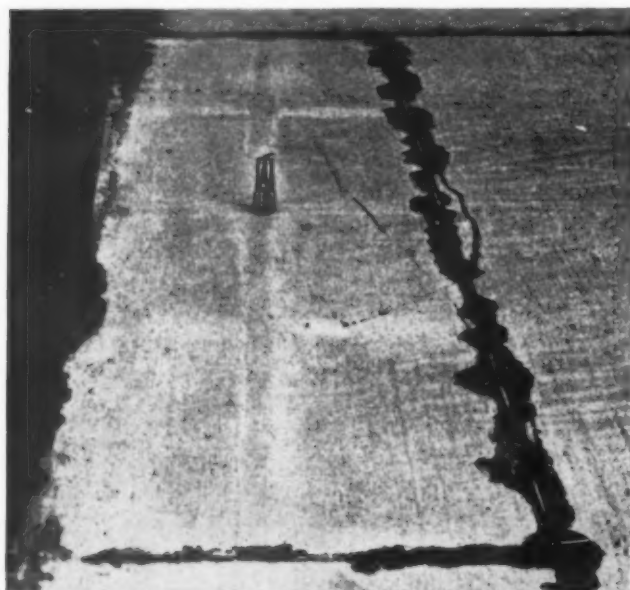
Accelerated Scaling of Concrete in Test Panel. Size of Panel 3 Ft. by 12 Ft.

the above mentioned instructions. These observations will include continuation of measurements of moisture content, temperature of slab, but for the most part will be concentrated upon the study of surface scaling due to action of traffic and climatic conditions.

Special Scaling Study.—During the actual service life of the pavement and for a period of 3 to 5 years, it is planned to study or observe certain sections of the project under the action of ice and salts in an accelerated manner.

The correlation of the observations made during construction and actual service together with the test information of the special scaling study should enable the Research Division to evaluate the many factors and determine their relative importance under the conditions imposed.

In conducting the scaling study definite pavement sections 120 feet in length were chosen with respect to the various concrete mixtures and surface treatments involved in the construction of the pavement. In each section two areas were dyked off, each area being 3 feet wide and 12 feet long. The dyked areas were established along the east edge of the pavement and parallel



Unscaled Concrete in Test Panel

to it. Safety precautions were maintained day and night to warn traffic of the presence of the test areas and to prevent accidents.

Two different types of accelerated test methods were employed. In test area "A," a 10 percent solution of calcium chloride of $\frac{1}{4}$ inch minimum depth was applied and allowed to remain in place 5 days. At the end of this period, the solution was removed, the panel flushed and water applied to a depth of $\frac{1}{4}$ inch. After the water had frozen, the ice was melted by an application of 5 pounds of flake calcium chloride per area. When the ice was decomposed, it was removed from the test area, the surface was flushed and allowed to rest one day before completing the next cycle.

Test area "B" received a different treatment. Water was applied to the test area and allowed to freeze over night. The following morning the ice was melted by distributing calcium chloride over the area at the rate of 5 pounds per area. When the ice was decomposed it was removed from the test area and the surface was flushed. Fresh water was applied to the test area and the freezing and thawing cycle repeated. On the basis of the quantity of water resulting from the melted ice in each test area, it was calculated that 5 pounds of flake calcium chloride would be sufficient to produce a 10 percent solution.

It is proposed to carry on these tests for several years to determine what effect age has on the ability of concrete to resist freezing, thawing and calcium chloride treatments. Consequently, no calcium chloride has been applied to the durability section of the Test Road except at test areas. Each winter the test areas will be established in the same section and adjacent to the previous test areas.

The first of the series of scaling studies which were conducted during the past winter have been completed. The results obtained so far indicate that certain treatments of the concrete or its ingredients will tend to influence the ability of the concrete pavement to resist scaling caused by the application of calcium chloride for ice removal. Preliminary conclusions tend to show that the ability of concrete to resist scaling caused by the action of chloride salts can be materially improved by the addition of certain additives. This is particularly true of Orvus, Vinsol Resin and Calcium Chloride.

Concluding Remarks

The value of these studies to the Michigan State Highway Department will depend entirely upon the manner in which the findings are applied to current and standardized practice. It is hoped as soon as definite conclusions are obtained they will be transmitted to the various divisions concerned and if feasible, the recommendations will be incorporated in the specifications. In some cases, it will be necessary to construct only a few projects including these changes and obtain further substantiating data as to the effectiveness of the newer practice. It is hoped that the facts and relationships finally obtained from both the design and durability sections will assist in obtaining the whole answer to many controversial issues and will serve to aid the Michigan State Highway Department, as well as other highway organizations in the development and improvement of concrete pavements.

Army Will Have 286,000 Motor Vehicles by Early Fall.—Two years ago the total number of Quarter-master motor vehicles in the Army was about 14,000. On May 1 there were about 190,000. By late summer or early fall a goal of 286,000 will be reached, the number now considered necessary for an army of 1,400,000 men.



Curing Green Concrete With Cotton Quilts

Cotton Quilts

FOR CURING CONCRETE PAVING

Survey of Curing Methods Shows What State Specifications Permit

SUBSEQUENT to the concrete finisher's job on a portland cement concrete road construction project, the green concrete must be cured. Many different processes have been used and many have been stipulated in the specifications governing various projects.

In an effort to promote a greater consumption of cotton Congress passed legislation in August, 1935, which made it possible for the states, as well as the federal government, to experiment with cotton quilts for curing concrete. Briefly, for roadwork it was provided that:

The federal government, through the Cotton Marketing Section and with the cooperation of the Bureau of Public Roads, in accordance with the provisions of the legislation, shall make avail-



Moving Bridge to Next Setting for Placing of Cotton Curing Mats



Photo Courtesy Public Roads Administration
Placing Cotton Blanket On Concrete On U. S. 40 South of
Aberdeen, Maryland

able to the highway departments of the various states such supply of cotton mats and cotton fabric as may be requested in amounts sufficient for adequate trials and demonstrations. These materials will be made available to the states on condition that the state highway department agrees to use them, or have them used, in an approved manner in road construction, and also upon condition that the highway department uses reasonable diligence in securing and recording such information as may be necessary for a future evaluation of benefits derived.

The U. S. Dept. of Agriculture through the Bureau of Public Roads made 90,000 cotton quilts available, at a cost of \$355,000 to 23 state highway departments.

Curing Procedure

Specifications drawn up by the cooperating states provided that the cotton quilts be used in a manner similar to the way burlap was being used. The saturated mats

**ALTERNATE METHODS OF CURING AND PROTECTING FRESH CONCRETE HIGHWAY SLABS AS GIVEN TO
EDITOR BY LETTER FROM STATE HIGHWAY DEPARTMENTS**

STATE	Osnaburg Covered Cotton Quilts	Burlap Covered Cotton Quilts	Burlap Sheets Single or Double	Waterproof Paper on Fresh Concrete	Waterproof Paper after Wetted Burlap	Bituminous Material on Fresh Concrete	Bituminous Material after Application Wetted Burlap	Calcium Chloride	Colorless Curing Compound on Fresh Concrete	Colorless Curing Com- pound after Applica- tion Wetted Burlap	Silicate of Soda after Application Wetted Burlap	Hay or Straw after Application Wetted Burlap	Ponding after Application Wetted Burlap	Wetted Earth after Application Wetted Burlap
ALABAMA.....	X	X		X									X	X
ARIZONA.....	X	X	X	X	X	X	X		X	X			X	X
ARKANSAS.....	X	X	X ¹³	X ¹				X ³			X	X ²	X	X
CALIFORNIA ⁵			X ⁵		X*					X*		X ⁴	X	X
COLORADO.....			X	X					X	X		X	X	X
CONNECTICUT.....	X	X												
DELAWARE.....	X	X	X		X*			X				X		X
FLORIDA.....	X	X	X ⁵		X									X
GEORGIA.....	X		X ⁵		X								X	X
IDAHO.....		X							X*	X*		X	X	X
ILLINOIS.....	X*	X*	X ^{5, 14}		X			X ⁷				X	X*	X*
INDIANA.....			X	X ⁸								X	X	X
IOWA.....	X	X	X ⁵		X		X	X		X		X	X	X
KANSAS.....	X	X	X		X								X	X
KENTUCKY.....	X*	X*	X		X							X	X	X
LOUISIANA.....	X	X			X								X	X
MAINE.....					X							X		X
MARYLAND.....	X		X	X ¹		X		X	X					X
MASSACHUSETTS.....	X*	X*	X ⁵		X*							X		X
MICHIGAN.....	X	X	X ⁵			X*	X*	X*				X	X	X
MINNESOTA ⁹	X	X	X	X			X	X						
MISSISSIPPI.....	X		X ⁵	X ¹										X
MISSOURI.....	X		X	X ¹	X			X	X	X ¹⁰	X	X	X	X
MONTANA.....			X										X	X
NEBRASKA.....			X	X ¹	X*	X ²	X ²		X ¹	X*		X ²	X	X
NEVADA.....	X	X											X	X
NEW HAMPSHIRE.....				X								X		
NEW JERSEY.....	X	X		X		X						X		
NEW MEXICO.....	O	O	O	O	O	O	O	O	O	O	O	O	O	O
NEW YORK.....	X	X		X ¹	X		X ¹⁴	X ³	X*			X ²	X	X
NORTH CAROLINA.....	X	X	X		X								X	X
NORTH DAKOTA.....	X*	X*	X	X ^{1, 14}		X ^{1, 14}	X ¹⁴	X ^{3, 14}			X ¹⁴	X ¹⁴	X ¹⁴	X ¹⁴
OHIO.....		X			X			X*			X*	X	X	X
OKLAHOMA.....	X	X		X ¹					X				X	X
OREGON ⁶	X	X												X
PENNSYLVANIA.....		X	X		X ¹⁴		X ¹⁴	X ^{3, 5}				X ¹⁴		
RHODE ISLAND.....	X	X	X	X ¹				X ¹						
SOUTH CAROLINA.....	X	X		X ¹⁶								X ²	X	X
SOUTH DAKOTA.....			X		X								X	X
TENNESSEE.....	X	X	X	X ¹				X			X	X	X	X
TEXAS.....	X		X ¹⁷											X
UTAH.....				X		X*						X	X	X
VERMONT.....	X	X	X			X*						X		
VIRGINIA.....		X ¹	X ⁶	X ¹									X	X
WASHINGTON.....	X		X ⁶	X ^{1, 14}		X ^{1, 14}		X ^{1, 14}					X	X
WEST VIRGINIA.....			X					X			X			
WISCONSIN.....	X	X	X	X ¹⁸			X	X		X	X		X	X
WYOMING ¹¹									X					

EXPLANATORY NOTES

- X—Alternate curing methods included in specifications.
 *—If approved by the engineer or only if shown in special provisions of specifications and/or plans.
 O—Does not build concrete pavements.
 1. If no hair checking or crazing develops. If it does, then wetted burlap must be applied as the preliminary curing method. In Arkansas, cotton quilts are used instead of burlap for preliminary curing.
 2. In freezing weather.
 3. May be used as an admixture, also, upon approval by engineer, or if shown in special provisions.
 4. Saturated blanket of straw 4 in. thick permitted whether freezing weather or not.
 5. Regardless of subsequent curing procedure all concrete shall be covered while fresh with heavy burlap laid directly upon the pavement, and kept wet, as preliminary curing.
 California also permits continuous spraying with water after burlap is off.
 6. Wet burlap not permitted for entire curing, is preliminary curing for certain conditions.
 7. After wetted burlap preliminary curing.
 8. Only in cities or towns.
 9. Minnesota frequently limits the alternate methods of curing

to those specifically mentioned or listed in the special provisions of a particular project.

10. If hair checking or crazing develops before transparent membrane is applied.

11. With waterproof paper initial burlap cure is required whenever the weather conditions and the nature of the concrete mixture are such as to induce hair-checking. Also, if hair-checking develops.

12. No material having a color appreciably darker than the natural color of the pavement shall be used.

13. Burlap required in initial curing for all methods except when cotton mats or waterproof paper is used.

14. Approved quilted covers can be used instead of burlap.

15. Oregon permits use of wetted sawdust after preliminary curing by burlap.

16. Permitted only when pavement has hardened such that paper will not mar surface. Otherwise light weight burlap applied first.

17. For cases of emergency when pavement is to be opened after 72 hours.

18. When there is danger of frost, paper must be covered with protective layer of hay or straw.

19. Wyoming permits curing by either: (a) two coat applica-

tion of approved "colorless compound" or (b) approved "water curing" methods as further detailed below.

When water curing is used, their specifications read: "All concrete floors or slabs shall be covered as soon as possible with sand, earth or other approved material and kept thoroughly wet for at least seven (7) days. Where high early strength cement is used this period reduce to two (2) days." The words "other approved material" in the foregoing quotation could mean with them, either sawdust, burlap, paper or cotton quilts, assuming the amount and quality of any of these items used, were approved in each instance.

were placed on the green concrete, without marring it, and were kept wet for a period of 72 hours. This is a short curing period compared to the days when moist earth curing was required for at least 10 days.

The first experimental work of the Bureau of Public Roads was reported in *Public Roads* for July, 1933, and November, 1934. Another report appeared in January, 1940. The results of the field testing done by Texas was reported in *ROADS AND STREETS* for May, 1935, and in *American Highways* for July, 1935.

Cotton quilts absorb and retain an enormous amount of water, compared to burlap, for example, so that one wetting per day is sufficient for the curing process. The resultant concrete has proved to be much stronger than previously obtained. Page 73 of the booklet, "Concrete Pavement Manual," by the Portland Cement Association, Series No. 5, states as follows: "Excellent results have been secured with this method [cotton quilts] which insures a supply of moisture for curing and protects the pavement from temperature changes during the curing period, when concrete has little strength to resist temperature stresses."

One state highway department requires that the cotton quilts be kept wetted for a period of 96 hours. This is 24 hours longer than the period indicated as sufficient by experimental work. This additional period is justified on the grounds that, "taking into consideration the high initial cost of concrete pavement, the cost of sufficient cotton quilts to cover the concrete for an additional 24 hours was small indeed, if only the very strongest concrete was to result."

It has been learned that the quilts, if a little too long, must be folded on top of, and along the edge of the pavement. This is to prevent rotting of the cloth. The edge of slab, after the form is removed, is banked with earth.

In placing the quilts on the concrete, each one is lapped over the 6 in. flap of the adjacent quilt. This insures complete coverage. Full length mats may be easily handled by two men working off of a bridge. In removing quilts they should not be dragged as the center will wear out quickly. When saturated, full length quilts weigh approximately 100 lb.

Survey of Curing Procedure

The value of cotton quilts for curing led to a survey of curing methods as specified by the various state highway departments. Because of the large surplus of baled cotton on hand, and because of the excellent results that had been obtained on the cooperative curing project, it was felt that part of the surplus cotton should find a ready market in the highway field. It is estimated that the Commodity Credit Corporation controls over 11,200,000 bales of cotton, mostly low-grade, against which world markets have been closed. To use some of this surplus in batting would not only be a patriotic action but at the same time it would relieve the federal government of about 20,000 bales of raw cotton for cotton quilts on roadwork that would move at no loss to any sub-division of government. At present where burlap is used cotton

or waterproofed paper should be specified. The substitution of cotton or paper for burlap can be made at no extra cost per square yard of pavement. The results of the survey are shown in the accompanying table.

Quilt Size

The quilts used in the experimental work weighed approximately 24 oz. per sq. yd. They were made by stitching cotton batting, about 12 oz. per square yard, between cotton "osnaburg" sheets which weighed about 7 oz. per square yard. "Osnaburg" is a trade name for a fairly coarse-woven cotton fabric made from the poorer grades of cotton. The full-length quilts were 22 ft. 6 in. long by 5 ft. 9 in. wide and were quilted longitudinally by rows of stitching not more than 4 in. apart. For overlap, a 6 in. flap was provided along one longitudinal edge by sewing the cover together without batting. Some shorter quilts were also provided.

The quilt covers are made of unshrunk cloth and consequently, when wetted, they change in dimensions. Data indicate that this change amounts to about 6 per cent for shrinkage in the long direction and about 11 per cent in the width. Experience has also shown that quilts should not be so long as to remain in contact with the soil during the curing period. It was found that the edges disintegrate when this happens. Consequently, quilts are now made long enough to allow for shrinkage and any extra length is folded back on top along the edge of the slab.

It has been suggested that a cotton quilt be designed with a filler of 18 or 20 oz. of cotton batting in place of the usual 8 or 10 oz. Such quilts would retain a greater amount of moisture for a longer period and at the same time increase materially the consumption of low grade cotton.

In many specifications, burlap is stipulated to be used with cotton batting filler. Sometimes, as shown by Table I, burlap may be used alone. Burlap is an imported product. It comes from India in rolls of 2,000 yd. With oceanic shipments becoming more difficult and the need for ships for other purposes more pressing, burlap must rise in price. So the question is asked by American growers of cotton and American cotton fabric manufacturers, "Why not use cotton instead of burlap, particularly when stronger concrete results from its use?" Besides the lower cost, they claim that cotton quilts will withstand four times the number of uses that ordinary burlap will withstand.

Costs

The estimated life of a cotton quilt that has had ordinary care can be conservatively placed at 50 uses. Extra care in drying and storage should increase this by 10 to 50 per cent. The cost of curing concrete pavement as revealed by reports from 19 states, excluding the cost of the quilts, but including supervision, labor, and transportation average 2.15 ct. per square yard. The range, because of variable local conditions, was from 1.08 ct. to 3.11 ct. per square yard.

The cost of the quilts themselves is dependent upon the care taken of them as well as upon first cost. If they are rolled or folded and left damp, even for a few days, mildew attacks them and destroys the fabric. They must be thoroughly dried at the end of a job and before storage. Under favorable conditions this may be accomplished directly on the slab, but in the Northern States, the weather is generally unfavorable for this procedure so the quilts must be artificially dried.

When stored they should be periodically inspected for mildew.

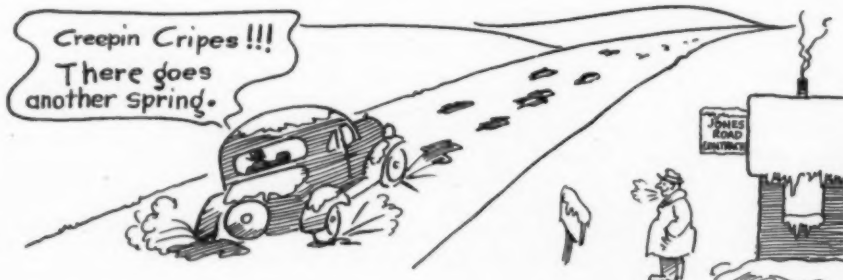
OBSERVATIONS BY THE WAY

By
A. PUDDLE JUMPER

¶ E. L. Worthington, State Maintenance Engineer, West Virginia, contributed the following two pic-



tures of a unique retaining wall to prevent erosion at the bridge across Huff Creek on W. Va. Route 10 at Man in Logan County, West Virginia. The retaining wall is old automobile bodies loaded with rock.



¶ A. P. J. learns about snow and ice non-removal at first hand. Bill Jones, Road Contractor, is too wise to drive a car on such roads.

¶ Herewith a view of the flooded Trinity River northwest of Dallas,



Texas, on U. S. 77. A. P. J. jumped a couple of puddles like this that morning.

¶ I'll bet both of the patrolmen on State Route 13 in Kansas would be tickled pink if the state would give them some corrugated culverts for those farm entrances. Yes, and for that bridge by that extremely dangerous underpass.

¶ Can anyone give me just one good reason why U. S. 13 in Maryland is so much inferior to either Delaware's or Virginia's portion of this direct route from New York to Norfolk and points south? "It looks like a Maryland road" is getting to be a by-word which is synonymous with obsolete, crooked, and antiquated, in roads.

¶ Maybe Maryland is just trying to discourage traffic over that route because of that \$3.50 ferry at Cape Charles. If so, that's not such a bad idea, but they should put up signs to that effect.

¶ Highway designs and construction in North Carolina has undergone considerable improvement in the last few years. While a certain amount of provincialism is still evident, the general standard of design has greatly improved.

¶ In a few more years North Carolina may begin to flatten and round off the backslopes of cuts!—who knows? The politicians and highway authorities may even pay some attention to the data being collected by the Statewide Highway Planning Survey. Again, who knows?

¶ I understand that a speed record for building construction has been established at Ft. Bragg, N. C., where it is claimed, a new building was completed every 28 minutes.

To the tune of Yankee Doodle, "It may be so, but I don't know; They say he's not a liar."

¶ So many bold adventurous souls populate this country, it seems queer to me that no one has ever crossed the Dismal Swamp in North Carolina, on foot. They tell me men have flown over it but no one has ever

hiked across it. 'Sfunny! That's one for Ripley.

¶ Speaking about swamps reminds me of the wild fowl refuge in North Carolina called Lake Mattamuskeet. To open the section up for tourist travel the state is building a road straight across the lake because it is cheaper than going around the end. It has about a 30 ft. top and 20 to 1 side slopes. A dragline and a 10 in. suction dredge are doing the job. The lake is only about 3 ft. deep.

¶ On State Route 5 in Alabama I took this picture which shows several features in the one picture:

1. Wooden curb along shoulder of fill.
2. Treated wooden drainage chutes. These extend through the slightly raised curb and down along the



fill slope. They are asphaltic lined, also.

3. Creosoted square wooden guard rail posts with zinc caps covering top of post.
4. Grass ditch cheeks (in background), to prevent erosion.
5. Cable type guard rail.
6. Traffic striping on bituminous surface.
7. High standard sight distance and width.
8. Easy grades in rolling topography.

¶ One would think, at first glance, that this was a grave yard. It's not. It is a view on U. S. 17 just south of Savannah, Ga. Crosses like this are scattered all over Georgia along the roadsides. To really serve the purpose for which they were planted it seems to me that they should be made at least 6 ft. high and illuminated so that they can be seen from



a distance. After all, an accident situation is created long before the vehicle reaches the site of accident.

¶ Going south over the run out of the Jackson Hole country of Wyoming on my way to Kemmerer to spend the night, I was impressed with the active snow removal work of the Wyoming Highway Commission. During the blizzard that was blowing I could hit up to 70 m.p.h. at times.

¶ South of Kemmerer on the road to Evanston, Wyo., I was struck with the efficiency of the streamlined cross-section in keeping the roadway free of snow. No snow plows were at work. The wind was blowing ground blizzards across those wide sweeps of plains but none of it stayed in drifts on the roadway either in cuts or on fills. The snow blown across in streamlined style exactly as the cross-section had been designed to make it do. Another very noticeable point was that where short sections of snow fence were installed, the roadway surface was perfectly clear and free of snow. Good work Wyoming. Let's hope that all states where snow falls and blows adopts as efficient a cross-section. I'd read about this streamlined cross-section design but I'd never seen it in action until that storm at the end of February.

If light conditions had been favorable I would have taken a picture.

Incidentally, W. W. Clyde & Co., contractors of Springville, Utah, did an excellent construction job on this stretch.

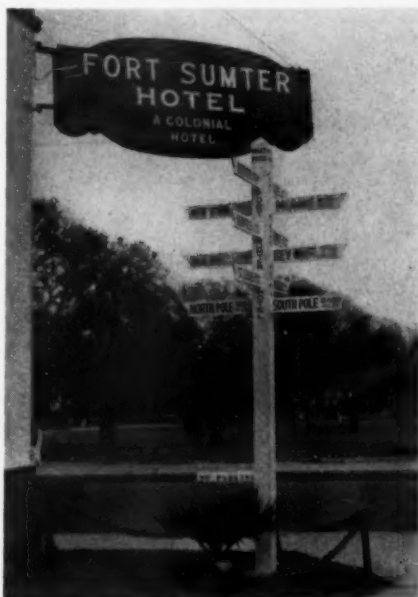
¶ At Casper the question came up, "Can engineering judgment be taught?" A professor thought it could. I cannot agree. What do you think?

¶ While I'm talking about this 50-mile stretch of road between Kemmerer and Evanston, Wyoming, I might mention that there are no towns between these two and that the W. P. A. have erected three or

four "shelter shanties" along the route. Each is equipped with a stove so that anyone getting caught out would not freeze to death until help arrived.

¶ Speaking about the Riverside Club at Casper, Wyoming, I. E. "Scotch" Russell, materials engineer for Wyoming, was also having the time of his life. Is it true "Scotch" that you'll have to toss your hat in the house before you go in when you get back to mama? If she throws you out, just blame it onto Eby of Billings, Mont.

¶ At the intersection of King Street and Murray Boulevard in Charleston, S. C., stands the Hotel Fort Sumter at the corner of which this sign post stands. The directions read as



follows, left to right, and top to bottom:

New York, 761 Miles—Miami, 625 Miles

Quebec, 1293 Miles—Key West, 771 Miles

North Pole, 3954 Miles—South Pole, 8480 Miles

I never jolted down the notations on the other direction.

¶ North Carolina has a maintenance man for black top patching of which they may well be proud. He did excellent work on U. S. 64 just east of Pittsboro. Send him a note of encouragement on his work, Mr. Baise.

¶ While I'm talking about this piece of U. S. 64 in North Carolina I cannot help but take a dig at those pole and lumber culverts along that otherwise fairly good road.

FOUR LANE ROAD BUILT WITHOUT DETOUR

Old Grade and Alignment Generally Followed in Widening

By G. H. EHRINGER

Senior Resident Engineer, North Carolina
State Highway and Public Works Commission

PRECEDING the movement for reconstruction of roads to meet the "Defense Program," the North Carolina State Highway and Public Works Commission, under the direction of its chief engineer, W. Vance Baise, let to contract on August 27, 1940, for re-

to the mainline of the Southern Railway; and there being a large volume of population in the immediate vicinity, a continuing increase may be anticipated so long as prevailing business conditions continue. The traffic on this road appears to be more affected by business conditions

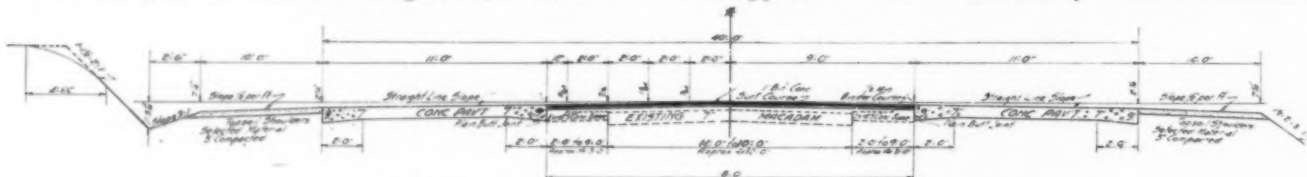


Fig. 1.—Typical Section Showing Existing Base and Concrete Widening

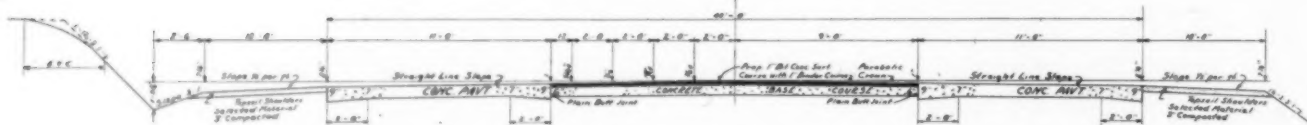


Fig. 2.—Concrete Base Course and Extra Lanes as Widening on Relocated Sections

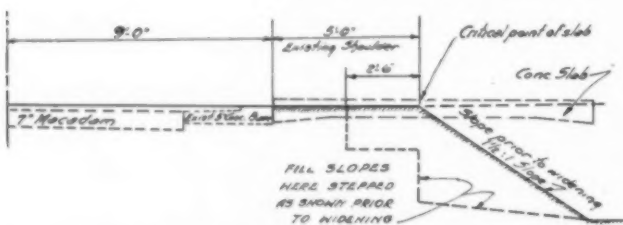


Fig. 3.—Showing How Old Fill Slopes Were Handled for Widening of Pavement

construction by widening the existing 18-ft. pavement to a 40-ft. pavement on a section of route U. S. 29 between Salisbury and China Grove in Rowan County, 6.83 miles long.

The completion of this project resulted in a dual highway on which concrete was used as paving for the heavily traveled lanes and an asphaltic surfacing laid on the existing 18-ft. roadway on the less used center lanes. This type of construction also resulted in a marked advantage of permanent color marking for the roadway lanes.

The traffic count definitely indicated that this section of highway carried more vehicles per day than any other 18-ft. pavement in the state, thereby making it one of the main links in the state's strategic highway system. The traffic on the China Grove-Salisbury section of U. S. 29 has been increasing at a very fast rate for several years, and this increase appears to continue. In 1935, the traffic was 3,416. In 1937 it was 3,674. In 1939-1940, it was 4,876; and it would not be surprising to see a 1941 volume of more than 5,000 vehicles per day. This section being in the heart of industrial Piedmont, parallel

and the rate of industrial production than any other factor.

The grading and paving were performed without the establishment of a detour. The contractor maintained traffic during the entire construction period without an accident and in the face of the heavy traffic this was quite a performance in itself.

The right of way limits were extended from 60 ft. to 100 ft. All buildings, power poles, telephone poles and other obstructions within the new limits were moved to clear the new right of way.

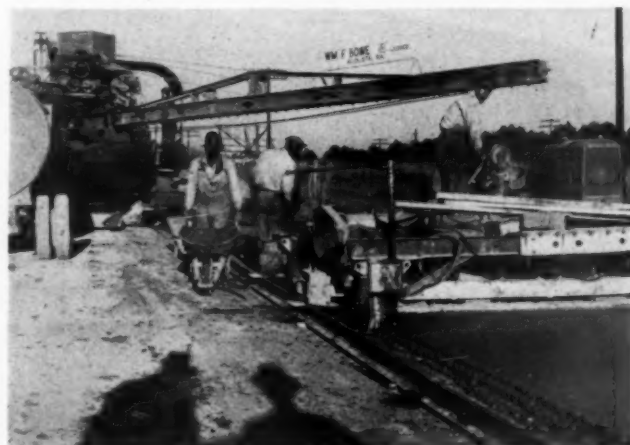


Fig. 4.—Finishing Screed Operating From a Railroad Rail. 27-E Double Drum Ransom Paver Mixed All Concrete. A Short Piece of the 9-in. Form with the Bottom Sheared Off Is Shown in the Lower Right Corner



Fig. 5—Subgrade Drag Operating Off of Railroad Rail Which Is Wedged to Grade on Old Pavement

Grading

The grading on this section of roadway was started on September 27, 1940. Excavation was handled generally by power shovel and wheeled hauling units. Fill slopes were made $1\frac{1}{2}$, 2 and 3 horizontal to 1 vertical and cut slopes, 1, $1\frac{1}{2}$, and 2 horizontal to 1 vertical. The grade lines followed the existing 18-ft. road with the exception of the relocations. Two typical sections of the pavement as laid are shown in figures 1 and 2.

All corrugated and concrete culvert drainage pipe lines were extended to take care of the widened section. After the extension of the pipe lines the fills were broken down in order to obtain a good bond as the critical section fell in the center of the new concrete slabs, as shown by figure 3. There were no new bridges on the project.

All fills were placed in 6-in. layers and rolled with a three-wheeled 10-ton roller.



Fig. 6.—Prepared Subgrad. Note Railroad Rail Set to Grade on Old Pavement. Also Note Forms with Bottom Flange Sheared Off Ready to Be Pushed Into Poured Concrete Along Edge of Old Surface

Several grade changes were made which required the removal and disposal of 4,500 cu. yds. of broken concrete and bituminous macadam pavement. This pavement laid in 1918 and 1922 was 18 ft. wide with shoulders 5 ft. wide on each side. The old paving was broken with a truck mounted, gasoline-engine-powered hoist operating a drop hammer which broke up the paving as the truck moved slowly ahead. A 1-yd. shovel, powered by gas, was then able to load the material into trucks for stock piling along the right of way.

Concrete Paving

The widening of the existing pavement was begun on October 31, 1940, and was completed February 8, 1941.

The pavement consisted of two simple 9-7-7-9 in. slabs 11 ft. wide. Superelevation and spiral easements were used at almost all curves. Contraction joints were placed every 30 ft. and a 1-in. premolded expansion joint was placed every 120 ft. A Nelson spotter was employed in placing the expansion joints and all joints were vibrated. Stone shoulder drains were placed on the right and left of each expansion joint.

The relocated sections of the highway called for a new



Fig. 7.—Finishing New Lane to Grade of Forms After the Form with the Bottom Flange Sheared Off Has Been Pushed Into Place, Wedged, and Graded

6-in. concrete base course 18 ft. wide, which was poured after the two 11 ft. lanes were completed. The concrete base course was finished smooth and free from broom marks.

The failures in the existing 18-ft. roadway were removed and replaced with a 6-in. concrete base course. A total of 2,360 sq. yds. was placed in this manner.

All aggregates passed the North Carolina State Highway and Public Works Commission specifications with the following gradations:

SIZES COARSE AGGREGATE				
TOTAL PER CENT PASSING SQUARE OPENING SIEVES				
$2\frac{1}{2}$ in. 100	2 in. 95-100	1 in. 35-70	$\frac{1}{2}$ in. 10-30	No. 4 0-5

SIZES FINE AGGREGATE				
No. 4 97-100	No. 8 80-100	No. 30 25-75	No. 50 5-30	No. 100 0-7

DESIGNED MIX FOR CONCRETE PAVEMENT

Cement, pounds	94
Sand, pounds, plus moisture	230
Stone, pounds, moisture included	377
Water (maximum), gallons per bag of cement	6.4
Cement factor (including moisture in aggregate)	1.35
Yield, cubic feet per sack of cement	5.0



Fig. 8.—Lorain Crane Roughly Proportions Aggregate Mixture for Bituminous Courses from Stock Pile

DESIGNED MIX FOR CONCRETE BASE

Cement, pounds	94
Sand, pounds, plus moisture	254
Stone, pounds, moisture included	406
Water (maximum), gallons per sack of cement	6.9
Cement factor (including moisture in sand)	1.25
Yield, cubic feet per sack of cement	5.40

Coarse aggregate was furnished by the Raleigh Granite Company, fine aggregate by Material Sales Company, and cement by the Signal Mountain Cement Company. All cement was delivered in bulk, in hopper bottom cars. Cars generally were unloaded by a screw conveyor under



Fig. 9.—General View of Asphalt Plant Dryer Belching Black Smoke. Note Two Liquid Asphalt Tanks, One Truck Mounted. Steam Used for Heat and Energy

the track to a steel portable bin from which the cement was weighed and dumped into the batch trucks. All hauling to the paver was done by trucks on a batch-mile basis. All coarse and fine aggregates were stock piled after being unloaded from gondola cars by a clamshell. Aggregates were measured and batched by weight. Fine aggregate was weighed separately from the coarse aggregate.

All mixing was done by a practically new 27-E Ransome double-drum type mixer. Water for mixing was hauled by two 1,000-gal. tanks mounted on trucks.

The placing of concrete was carried on during the entire winter months. In order to overcome the freezing of the fine aggregate two 18-in. galvanized iron pipes



Fig. 10.—Closeup of Pug Mill Preparing Binder Course Mixture. Upper Left Corner Can Be Seen Part of Powdered Asphalt Storage Bin. Bucket for Measuring Out Powdered Asphalt Is Setting on Platform



Fig. 11.—Hard Asphalt Cement Is Reduced to a Powder By a Small Hammer Mill. Fan Blows Powdered Asphalt to Storage Bin

were placed through the sand pile and a continuous fire was kept in them. At the mixer a solution of calcium chloride was introduced into the mix to the amount of 1 pound per bag of cement. The chloride was used only to accelerate the hardening of the concrete and not as a curing agent.

After the finished subgrade was prepared, the forms were set and kept true to line and grade. All forms were staked with not less than three pins.

The concrete after being deposited from the mixer was struck off by a mechanical finishing machine equipped with two screeds. The finishing machine was moved over the entire area only once except on the re-located sections where regular forms were used on each side of the lane to be poured, the finishing machine was brought back as many times as was necessary.

In order to obtain the raised edge over the old pavement the finishing machine screeded the concrete from a



Fig. 12.—Dumping Hot Binder Mixture Into Finishing Machine Hopper

railroad rail which was set to grade, as shown by figure 4. The new concrete was butted against the old base and the finished surface therefore was raised above the old base.

After the concrete was struck off a 9-in. form with the bottom flange sheared off was pushed into the concrete along the face of the old pavement. These forms were lined to grade by transferring the grade from railroad rail to the forms. They were held to grade by wedging them up with oak wedges. A transverse float and straight edge were then employed in finishing the concrete. Finally a bow-belt, moved with a combined cross-wise and longitudinal motion, was used in order to obtain a surface with a herring-bone finish.

The surface of the concrete was straight-edged along the center and both quarters using a straight edge 12 ft.

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SHOVEL STARTS
Talking Your
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TURNTABLE

1. Double Center Drive pinion which
- 2. Applies power directly—fully concentrated on any one operation—
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4. Two-piece swing drums designed to take the punishment of the hardest worked part of the shovel.
5. Crowd clutch, extra wide to deliver full digging power, mounted on roller bearings; two-piece, easily reversed bands.

CRAWLER

1. Center "Chain" Drive.
2. Two speeds either direction.
3. Steers either direction.
4. Safety travel and tread lock.
5. Mechanism runs in oil bath.

6. Generous underneath clearances.
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SHOVEL BOOM

1. All-welded (strength; all-steel; torsion-resisting).
2. All-steel dipper stick.
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1. Simultaneous hoist, swing and travel (or boom derricking).
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It's the speed with which a shovel gets material *into* and *out* of the dipper that determines your profits. The true worth of the Lorain-80's 21 design features is best proved by the fact that when faced with tough, big yardage rock jobs, such as the one above, scores of contractors turn to this machine for profit protection. And that means just one thing—the Lorain-80 has proved to their satisfaction its ability to *move more material, faster, at lower cost*, regardless of the digging.

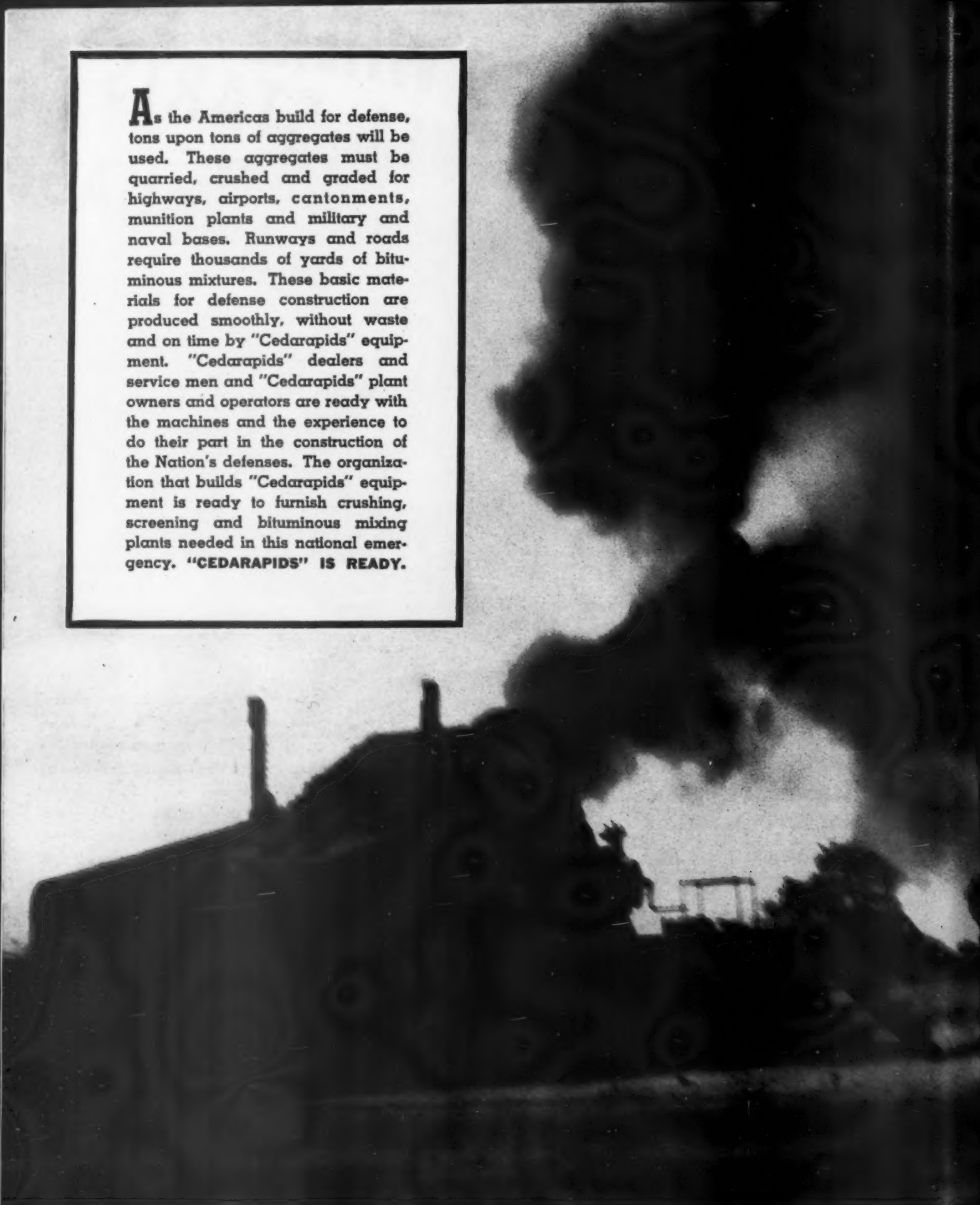
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As the Americas build for defense, tons upon tons of aggregates will be used. These aggregates must be quarried, crushed and graded for highways, airports, cantonments, munition plants and military and naval bases. Runways and roads require thousands of yards of bituminous mixtures. These basic materials for defense construction are produced smoothly, without waste and on time by "Cedarapids" equipment. "Cedarapids" dealers and service men and "Cedarapids" plant owners and operators are ready with the machines and the experience to do their part in the construction of the Nation's defenses. The organization that builds "Cedarapids" equipment is ready to furnish crushing, screening and bituminous mixing plants needed in this national emergency. **"CEDARAPIDS" IS READY.**



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WITH A COMPLETE LINE OF PORTABLE OR STATIONARY CRUSHING, SCREENING, WASHING, BITUMINOUS MIXING AND MATERIAL HANDLING EQUIPMENT FOR CONSTRUCTION OF CANTONMENTS . . . AIRPORTS . . . ROADS . . . AND OTHER DEFENSE REQUIREMENTS.



ASPHALT PLANTS . . The most complete line in the industry. Plant capacities ranging from 1000 to 4000 pounds, either portable or stationary. Batch type or continuous type mixers. A plant to meet any bituminous specifications.



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CEDARAPIDS PORTABLE STABILIZER PLANT . . A big capacity, continuous-mix type plant for mixing clay and gravel with any specified binder. Proportions accurately, mixes thoroughly and is completely portable. A high production, dual-purpose plant with a low operating cost.

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in length, as specifications permit only $\frac{1}{8}$ -in. variation in 10 ft.

Curing of concrete was done by burlap mats for 12 hours during cold weather operations and for 4 hours during normal conditions. These were replaced with Sisal-kraft paper for 72 hours. The traffic was excluded from the concrete for 14 days.

Asphalt Paving

The final phase of construction consisted of placing a plant-mix bituminous binder base course and a 1-in. bituminous wearing surface. Both courses were of the Westphalt type. Prior to the placing of the base course a squeegee coat of hot asphalt cement was applied at a uniform rate of 1/12 gallon per square yard. Following Westphalt mixtures were used:

COMPOSITION OF THE MIXTURES

BINDER COURSE

Flux oil (liquid asphalt)	5.6 per cent
Screenings	30.0 per cent
Stone	63.7 per cent
Asphalt (hard)	0.7 per cent
Total	100.0 per cent

WEARING SURFACE

Flux oil (liquid asphalt)	8.1 per cent
Sand	35.4 per cent
Screenings	54.6 per cent
Asphalt (hard)	0.9 per cent
Total	100.0 per cent

Plant Setup.—The asphalt plant was assembled from individual units and made to function for the capacity of the pug mill. It produced mixtures at the rate of 500 tons per 10-hour day.

A Lorain crane with a $\frac{3}{4}$ yd. clamshell roughed out the approximate aggregate mixture from the various stock piles as it fed the bucket elevator to the dryer. The dryer worked pretty hard after a rain to keep the pug mill busy. All aggregates were heated to 325 deg. F. and elevated to vibrating screens over bins which stored the hot, dry aggregates until they were weighed for dropping into the pug mill.

Hard asphalt cement was received in steel drums, from which it was removed and passed through a small hammer mill that reduced it to a powder. A fan forced the powdered asphalt cement to a storage hopper beside the pug mill. Proper percentages were measured out for



Fig. 13.—Barber-Greene Finishing Machine Spreads Hot Binder Course



Fig. 14.—View of Finished Road; Bituminous Passing Lanes, Concrete Outside Lanes, and Selected Top Soil Shoulders

each batch and combined with the liquid asphalt being mixed with the aggregate in the pug mill. The liquid asphalt, which was received in 10,000 gal. tank cars, was heated in separate vats and pumped from there to the pug mill scale. Two large stationary boilers provided steam for all pumping, power, and heating. The plant was set so low that a ramp had to be dug under the pug mill so the hauling trucks could back down into it to receive their load.

Placing.—The binder course was hauled to the project by trucks and dumped into a Barber-Greene asphalt spreader and finisher. It was rolled with an 8-ton tandem roller. The thickness of the binder base course varied according to the condition of the existing base.

The Westphalt surface course was laid to a thickness of 1-in. with the Barber-Greene finisher. The finished surface was tested with a 10-ft. straightedge applied parallel to the center line of the pavement.

Quantities

The major roadway items consisted of the following units:

6,100 cu. yds. Borrow excavation.
69,600 cu. yds. Unclassified excavation.
5,800 cu. yds. Drainage ditches.
7,000 cu. yds. Topsoil shoulders.
24,410 sq. yds. 6 in. concrete base.
87,240 sq. yds. 9-7-7-9 in. concrete pavement.
260 lin. ft. 15 in. pipe.
2,860 lin. ft. 18 in. pipe.
510 lin. ft. 24 in. pipe.
100 lin. ft. 30 in. pipe.
200 lin. ft. 36 in. pipe.
72,270 sq. yds. 1 in. bituminous pavement mixture surface course (Westphalt "J" type).
5,151 tons Bituminous pavement mixture binder course.

Personnel

Representing the North Carolina State Highway and Public Works Commission were L. B. Peck, Division Engineer; M. E. Beatty, Assistant Division Engineer, and G. H. Ehringer, Senior Resident Engineer, in charge of construction.

The contractor was Wm. F. Bowe, Jr., of Augusta, Ga. Osborne Puckett was superintendent of grading and Charles Davant, superintendent of paving. The contractor for the bituminous pavement was Leon Ellis of Greensboro, N. C. Claude Willard was his superintendent.



Airplane View of Site With Old and New Routes Marked. Town of Redcliff Shown

Construction of

REDCLIFF ARCH BRIDGE

Steel Erection Continued Throughout the Winter. High in the Colorado Mountains

By KING BURGHARDT

*Structural Designer, Colorado
State Highway Department*

CONSTRUCTION of a high arch span in a very rugged section of the Colorado mountains is well under way. The bridge is located near the town of Redcliff, twenty-six miles northwest of Leadville on U. S. 24. When completed, it will eliminate more than a mile of mountain road, as the new line crosses the canyon of Eagle River at considerable height and saves the long climb in and out of the canyon.

The south end of the bridge is on a mountain side of about 1:1 slope and the two 55 ft. approach spans at this end are supported on a 12 ft. high abutment, a 58 ft. steel bent, and a 101 ft. steel bend at the start of

the main span. This span is a two-rib steel arch 318 ft. long, 85 ft. rise and 209 ft. from stream bed to bridge floor. It crosses the two-track mainline of the Denver and Rio Grande Western Railroad, Eagle River, and a combined grade elimination and river crossing highway bridge on the old road. The north end of the arch springs from a nearly vertical cliff extending from 108 ft. below the roadway to 175 ft. above this road. A 41 ft. approach span connects the arch span to this cliff. The design calls for a 30 ft. clear roadway with 18 in. walkways on each side. The floorslabs and curbs will be of reinforced concrete, supported on steel string-

ANNOUNCING

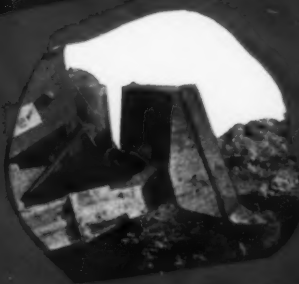
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BLADES HUG FRONT OF TRACTOR — Bulldozer and Trailbuilder blades hang close to radiator, greatly reducing load and wear on front idlers and track rolls. Note rigid, close-coupled construction.



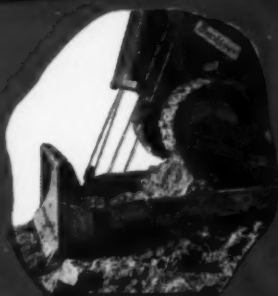
TRAILBUILDER EASILY ANGLED — It's a simple operation to install the extension to either side arm to angle the blade either way. A second member is also installed to give great rigidity.



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rigid, rugged frame that will take the battering of the toughest bulldozing without a whimper! • You get Cable Control at its best with Buckeye Power Control Units—smooth, fast action with no jerk on the line, greater lifting power, simplicity and freedom from trouble!

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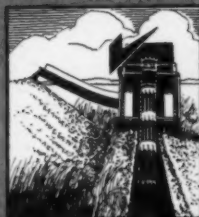
SEE OTHER COST CUTTING BUCKEYE EQUIPMENT ON PAGE 15

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Photo Courtesy Public Roads Administration
 Site of Redcliff Bridge Just Before Beginning of Bridge Construction Work. Cliff on Left Known Locally as "Lover's Leap"

ers, floorbeams and columns. For architectural reasons, all vertical bracing was eliminated and the bents were designed as rigid frames.

Excavation

It is necessary that a two hinged arch spring from unyielding supports, so the determination of the location of bed rock was of primary importance to the design. The highway department attempted to dig test pits at the ends of the arch span, but large boulders had dropped from the north cliff and the south end was in a zone of slide rock, just at its angle of repose, and the railroad tracks were directly below. So, it became evi-

dent that it would be advisable to make the necessary protection and complete the rough structural excavation at the time the test pits were dug. As the contract for the roadwork at the ends of the bridge was nearly ready for advertising, it was decided to include the rough structural excavation for the bridge in this contract. The C. A. Switzer Construction Company of Denver was the successful bidder on the roadwork, and the bridge excavation was specified to be the first order of business. Work was started in October of 1939 and before Christmas the site of the arch shoes was entirely stripped to bedrock. All electric wires were placed in conduits, the piers of the highway bridge were protected by log barricades and the excavation was made by hand, using small shots of dynamite when necessary. Bedrock was a very hard, igneous variety and was considered ideal foundation material, except where the south end of the west rib straddled a fault zone, with firm rock to the east and entirely unsuitable material to the west. This discovery necessitated a line change to swing the south end of the arch to where it would be on good rock.

Additional high lights in connection with Mr. Switzer's contract for the approaches might be outlined here.

This contract included about three miles of heavy excavation, amounting to approximately 400,000 cu. yds. of unclassified excavation which entailed 1,500,000 sta. yds. of overhaul. The excavation was mostly rock and was bid at 39 cts. per cu. yd.

The excavation contract required about 350 calendar days and was completed on October 18, 1940. The total contract bid was \$218,817.25.

Equipment used on this part of the improvement was as follows:



Photo Courtesy Public Roads Administration
 View Looking South Across Eagle Canyon. New Road Approach Shown. Lower Road Is Old Road



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With the foundation conditions known, the final bridge design was completed and on May 24, 1940, bids were opened for its construction. Frank M. Kenney of Denver was the low bidder with a total of \$139,627.50. Structural steel was bid at 8.94 cts. per pound and concrete at \$29.75 per cu. yd. exclusive of reinforcing. A contract was signed on May 26, specifying a completion date of 380 calendar days.

Substructure

With slow mill deliveries and complicated fabrication, the delivery of structural steel was not expected before September, so it was decided to wait until the grading contractor was all through with his work at the ends of the bridge, before starting concrete work. Accordingly, work on the concrete substructure did not start until July 1, and was completed in about two months.

The substructure consisted of two rather low abutments, four pedestals for arch shoes and two more pedestals for the steel bent of the south approach spans. Only the arch shoe pedestals offered any unusual problems. These footings each had a vertical front face but all of the rest of the sides were on the slope. The



South End Site. Pouring Pedestal For South Arch Shoe. Note Long Concrete Chute



First Arch Rib Section to Be Set. High Line Carrier and Tie Back Cable Can Be Seen

pedestal for the southwest shoe came in a gully in the mountain side, so that it was about 32 ft. high at one corner. This pedestal was made hollow with a 48 in. top slab and 18 in. side walls, stiffened by counterforts. The other pedestals were all comparatively low and were of solid concrete. Due to the very jagged rock at the bottom of all of these pedestals, it was not practical to prefabricate the forms, and all forms were built in place and fitted to the rock. The forms were kept from sliding downhill and from floating under the pressure of the concrete by ties to steel rods that were drilled in the rock and held by sulphur. The steep, slippery mountain side made working difficult and it was necessary to build platforms on the south side in order to make it possible to work at all.

For the north end, the lumber and concrete was lowered over the cliff from the roadway above, and at the south end all material was lowered by ropes on a wood chute while the concrete was spouted down a ten-inch pipe. The grade of this pipe was so steep that no trouble was experimented with segregation of the aggregate.

The highway department established line and grade for all anchor bolts. The distances between piers, particularly for the arch span, were very carefully established and checked, using direct measurements, slope measurements, and triangulation. The anchor bolts for the arch shoes were set in sleeves in the concrete and afterwards these bolts were very carefully adjusted and grouted in place before setting the arch shoes. Some four months later, this careful work was rewarded by a very satisfactory fit of the steel arch ribs.

Structural Steel Erection

The erection of the arch ribs presented a tough problem to the steel bidders. The arch was not of the trussed type, so the cantilever method of erection was out. The ribs were very high above the river bottom and there were tracks, a bridge and a stream in the way of falsework or of a guyed derrick, so the majority

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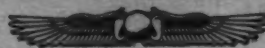
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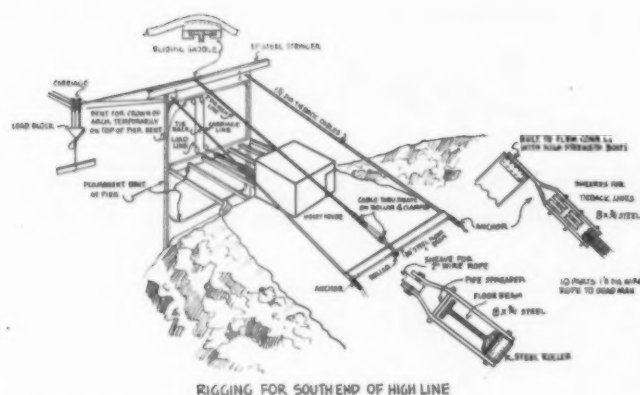
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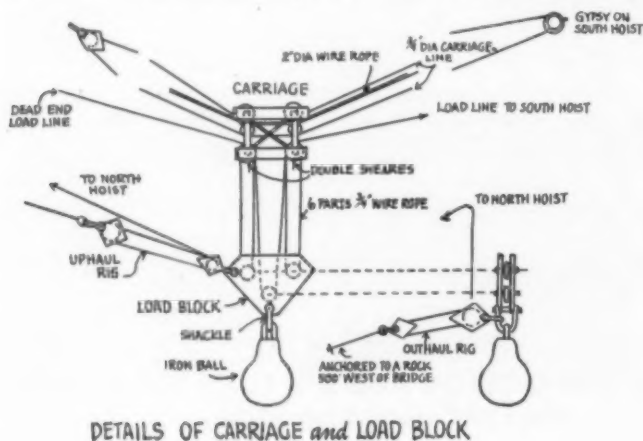
PC1-2



of the bidders planned on the use of a "high line and backstraps." The Minneapolis Steel and Machinery Division secured the subcontract for fabrication and erection, and their erection superintendent worked out an ingenious and satisfactory plan. It was decided that a single suspension cable could be used for all erection. The cliff on the north end was chosen in place of a tower to carry this cable. As this cliff was 175 ft. above the bridge floor, a very low tower is all that was required on the south end, and it was decided to use the steel bent that was designed for the center of the arch span on top of the steel bent between the south approach spans, for this tower. The north end of the high line hung about 13 ft. east of the center of the east rib, so it was necessary to outhaul the members to the west, particularly the members of the west rib. For the north half of the arch, the load was high up the suspension cable line and there was plenty of drift to make this outhaul, but near the south end the cable was just above the load and it was necessary to make the south end of the high line movable sideways to cut down on the outhaul. This was accomplished by anchoring each end of one of the floorbeams to a dead man and then attaching the south end of the high line to a roller that ran along the flange of this beam. A sliding saddle allowed the line to move over the south tower.

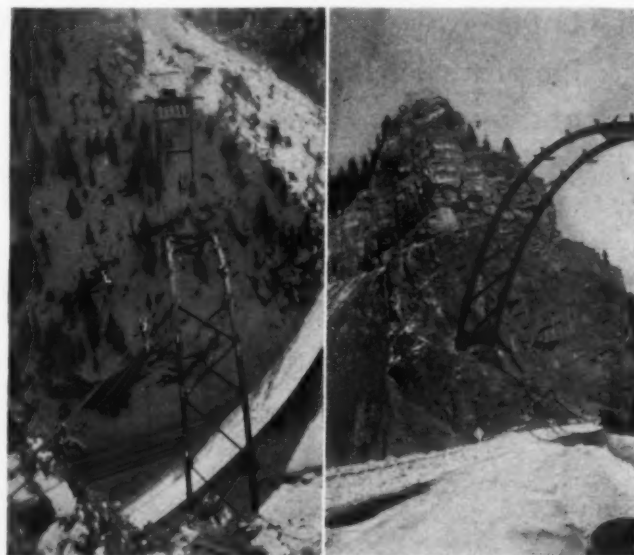
The high line consisted of 850 ft. of 2 in. wire rope that had seen similar service on the Boulder Dam. The dead man anchors were each made with ten parts of $1\frac{3}{8}$ in. wire rope. Three-quarter-inch wire rope was used for the load line, the carriage lines and the outhaul line, and the tiebacks for the arch rib sections consisted of from one to four parts of $1\frac{1}{4}$ in. wire rope. In all, over seven miles of wire rope was used to rig the job.

A gasoline hoist at the south abutment controlled the load line and the carriage line. A helper hoist, over



the high line on top of the north cliff controlled the outhaul and also helped pull the heavier loads up the high line when moving north.

Preparations for erection started the middle of August. First, the dead man pits were dug. These were three trenches, each about six feet deep in solid rock. Each dead man consisted of two 24 in. steel beams. Wire rope anchors were wrapped around these beams and came to the surface through inclined trenches in the rock. Then all of the trenches were filled solidly with concrete. Next the two hoists were set and lines from each hoist were united at the bottom of the canyon so that the line from the north hoist could be pulled to the south end and attached to the suspension cable. The north hoist pulled this cable across the canyon, using the niggerhead of the south hoist as a snub. The south end of the high line was temporarily set on a timber A-frame in order to set the steel for the south approach span and the erection tower. This steel arrived September 29 and was erected at once so that the high line could be raised on the steel tower. A month of fine weather was then spent in placing the tieback cables, setting the outhaul lines and adjusting the rig, as well as waiting for arch steel to arrive. Finally, on November 4th, the first shipment of arch sections arrived, accompanied by the first real snow of the winter.



Left: View From North Hoist House After Closure of Arch Ribs. Note High Line in Foreground. Right: Looking North From Old Roadway. Hoist House On Top of Cliff Barely Visible. Left Picture Shows Point Where Right Picture Was Taken and Vice Versa

Each rib came in six sections weighing from 17 to 22 tons apiece. The rib sections were hauled by truck from the depot, about a quarter of a mile away, to the highway bridge directly under the high line. As erection could not keep pace with the delivery of these sections, this steel was stored on each side of and across Eagle River until it could be raised. The remainder of the steel was hauled to the north end of the bridge and stored there. The bottom rib sections were raised first, pinned to the shoes and the upper end of each section tied in place by tieback cables which were attached to the dead man anchorages. As these bottom sections were the heaviest pieces on the job, all four of them were set first, with considerable slack in the high line. Then, this cable was raised to permit the setting of the remaining sections. The second sections were then spliced to the bottom pieces and their top ends held by tiebacks. The third, or center sections, were next placed

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and the north section was tied back while the south section, the closing piece, remained on the load block of the high line until after closure.

The north half of the rib was adjusted so that its center would be four inches above design grade. The south half was set so that its center would be four feet high. This was necessary as the bottom end of the closing piece had to be forked into its splice requiring that the other end clear the north half of the arch. Before closure, the tiebacks to the bottom sections were removed, leaving one tieback and the high line to hold the south half and two tiebacks to support the north half. All tiebacks had turnbuckles to allow lowering the rib sections for closure. The south half of the rib was first lowered until it was level with the north half and then both sides were lowered evenly until the rib was carrying its own weight on a temporary hinge at the crown. The west rib was completed first, each section being guyed against sidesway, and, as the sections of the east rib were raised, the bottom lateral bracing was set, so that the guys could be removed.

Erection of the arch steel came at the start of real winter weather. Work was plentiful in Denver and the union bridgemen could not see any reason to leave a job at home for winter work at an altitude of 8700 ft. Practically all of the arch rib steel was raised by a crew of one foreman, one timekeeper, two hoist operators and three bridgemen. This shortage of labor was a serious handicap to the contractor. The month of November was cold, but without much snow, so little time was lost, even though the men worked at temperatures of 18 deg. below zero. Every morning, the steel had a coating of frost crystals that made working on the sloping rib sections quite hazardous, but the small crew stayed with the job and the west rib was closed on New Year's Day, 1941. Just four weeks later, the east rib was together. Fortunately, November was the coldest month and as winter progressed, the temperature kept getting higher, although increasing snow caused some loss of time.

In January, erection work in the northern part of the country started shutting down for the winter and men became more plentiful, so three riveting gangs were started as soon as the second rib was closed. It was specified that all rib sections should be fully riveted before any further arch erection proceeded. Needle beams were hung between the two ribs and completely planked over, at each splice, so that there was room for the heater and the riveter. Light floats were used to reach the points that were too far from this main scaffold. In the morning, each gang was lifted to its scaffold on a platform hung from the high line. They took their lunches with them and spent the entire day high in the air with the winter wind continually blowing up the canyon. About half of the splice rivets had to be bucked from the inside of the rib and the buckers-up spent many days inside a 17 in. wide box girder on considerable slope. Some of the bottom laterals interfered with the splice rivets, so all possible laterals were left out until after the splices were riveted. The crowns of the arches were erected on temporary hinges and all of the holes in the crown splices were subpunched for field reaming. As the riveting of this splice changes the arch from three hinge to two hinge, it was specified that the first few holes were to be reamed and riveted at a temperature between 40 and 50 deg. in order to equalize temperature stresses in the rib. Due to the wide range in daily temperature in this mountain country, this provision caused no particular trouble.

The riveting of the rib splices was completed March 5, and erection of the bents and floor system for the

arch span started at once. The load line was changed from six parts of wire rope to two parts and the erection of this lighter steel progressed rapidly. At the time of writing, all of the structural steel is in place and about one more week of riveting will complete this part of the contract. Work is starting on the forms for the concrete floor but concrete will not be poured until weather conditions become more favorable.

Equipment

The rough country necessitated the use of more hand labor than is usual for a project of this size. Two ½ yd. Koehring and Jaeger concrete mixers were used for all pours. A Sullivan compressor and Ingersoll-Rand jackhammers were used for the excavation. The steel erector used two, two-drum hoists powered by automobile motors and a 105 cu. ft. two stage, air cooled, Ingersoll-Rand air compressor for riveting.

Personnel

The Colorado State Highway Department, under the direction of Charles D. Vail, Highway Engineer, prepared the plans and supervised the construction. H. E. Rowbotham is the Resident Engineer for both the road work and the bridge. Under P. S. Bailey, Bridge Engineer, the writer made the design and acted as representative of the bridge engineer on construction. The plans were checked and approved by the Public Roads Administration under the direction of L. F. Copeland, Senior Bridge Engineer for the Denver office.

The contractor's general superintendent is John Callahan and Earl (Doc) Lay has charge of the erection of the steel under N. P. Mettome, District Erection Superintendent.

TO FORMULATE POST-WAR ROAD PROGRAM

President Roosevelt has appointed an advisory committee to assist John M. Carmody, Works Administrator, in formulating a post-war program for a national system of inter-regional highways. The committee consists of Rexford Guy Tugwell, chairman of the New York Planning Commission; Thomas H. MacDonald, Commissioner of Public Roads, Federal Works Agency; G. Donald Kennedy, Michigan State Highway Commissioner; Bibb Graves, former Governor of Alabama; C. H. Purcell, State Highway Engineer of California; Frederic A. Delano, chairman of the National Resources Planning Board, and Harland Bartholomew, City Planner of St. Louis.

The committee will be known as the National Inter-Regional Highway Committee. It is to review existing data and surveys and upon completion of its review will report to the president not later than Oct. 1, outlining and recommending a limited system of national highways designed to provide a basis for improved inter-regional transportation.

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—City officials of Hartford, Conn., have estimated a saving of \$78,500 in the cost of night accidents on 10 miles of relighted streets over a period of two years. This is \$61,700 over and above the added cost of the installation of new lights. This saving in property damages and losses through personal injuries does not take into account the value of lives saved. In two years before lighting improvement on the 10 miles of streets, 12 pedestrian deaths occurred at night. In a similar period after the lighting improvement, there was only one night pedestrian fatality.

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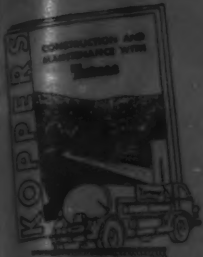
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TIMBER

FLORIDA HIGHWAYS

IN RELATION TO NATIONAL DEFENSE

By J. H. DOWLING

*State Highway Engineer
Florida State Road Department*

IN THE WAKE of an all-out national defense program the attention of defense minded America has suddenly centered upon the "area" of Florida—which area is one of the three vulnerable points in the defense of America.

Florida is strategically important because the peninsula is a spearhead that juts deeply towards our interests to the South. It is ideally situated for the location of air and naval bases that may be used as "outposts" for beating off possible invasions. Furthermore, the favorable climate of the state has been attractive to the location of certain defense industries and military training camps.

The government immediately realized the vulnerability of the state and began fortifying the defenses. Strong

naval bases have been established at Jacksonville, Key West, and Pensacola. Air bases have been located at Tampa, Jacksonville, Orlando, Tallahassee, and Valparaiso. One of the first problems brought to the front by the defense program was the condition of the highways and their ability to withstand military demands. A new form of warfare, based on blitzkrieg striking power necessitates dependable and rapid transportation.

Of the 44,413 miles of roads and streets in Florida, the State Road Department maintains 7,591 miles of the most important. A large portion of the state maintained mileage is woefully inadequate for even normal traffic demands.

Until now, the major construction activities of the State Road Department have been concentrated towards



New Type Bridge Design. Arch With Trestle Approach Over the Apalachicola River Near Blountstown, Fla.

COUNTY LINE TO COUNTY LINE



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Example of Divided Two Lane Pavements Now Being Constructed in Some Cases in Florida. A Four or Six-Foot Bituminous Center Strip Has a Rough Texture.

expanding and developing the state maintained system. For this reason, it has been impossible to accumulate reserves for the retirement of uneconomic surfaces. A large part of the present hard surfaces were improved by county bond money in the "boom" period from 1925 to 1929. Today, a large portion of that mileage has passed the economic service life and is in dire need of reconstruction. Unfortunately, the roads have been wearing out or becoming obsolete more rapidly than the income of revenues for rebuilding them and, since it has been unconstitutional to borrow money for that purpose, there has been a tremendous backlog of needed improvements.

Condition of Roadway and Estimated Cost of Needed Improvements

Approximately 60 per cent of the state maintained mileage has surfaces that are too narrow for present day demands. Approximately one-fourth of the mileage has surface widths less than 18 ft. and about one-half has surface widths less than 20 ft. Only 13 per cent of the mileage has surface widths of 22 ft. or more. Most of the needed widening should be effected on those roads whose present width is less than 20 ft. However, there are many miles of road whose surface width is adequate for a standard two-lane road but which should be widened to a divided four-lane highway because of



Typical of Many Miles of Depreciated, Narrow, Deteriorated Roads in Florida Which Must Be Reconstructed. They Have Lived an Economic Life.

high volumes of traffic. At present there are about 17 miles of divided four-lane roads on the state maintained system. Approximately 186 additional miles should be widened to four-lanes, making a total of 203 miles.

Motor vehicle operators are interested in the surface condition of a road because of its relation to ease, comfort, safety in travel, and economy in operation. Regardless of the type of pavement, the surface must be smooth and easy to traverse, if automobile operators are to be satisfied and vehicles operated at a minimum cost. A large number of the important roads in Florida fail to meet these requirements.

The economic life of approximately 3,600 miles of road surfaces has been expended. Approximately 2,100 miles of those surfaces should be reconstructed to the original type and approximately 1,500 miles should be reconstructed to a higher type.

As is the case in other states, reconstruction in Florida should include the elimination of inadequate sight distances and excessive curvature. Florida, a state with relatively flat lands, has no serious problem to steep grades (vertical curves), but many of the earlier constructed roads were designed for slower speeds and include horizontal curves that are too sharp for present day speeds. Today those curves affect the free movement of traffic by causing the vehicle to slow down and



Roadway Constructed on Top of Superstructure of Old Girder Type Railroad Bridge on the Over-Seas Highway to Key West, Florida, Known As Bahia Honda Bridge, 11 Towers 65 Ft. Above the Water.

by restricting the sight distance. On the trunk roads is an average of 20 curves per 100 miles that are 6 deg. or more. The critical condition created by these excessive curves is further reflected by the fact that eight curves per 100 miles of trunk road are in excess of 11 deg.

Estimated cost of needed roadway (exclusive of bridges) in the immediate future are as follows:

Type of Improvement—	Miles	Estimated Cost
New construction	107	\$ 5,701,000
Retread	247	2,019,000
Reconstructing surface only	785	13,323,000
Reconstructing surface and widening	2,813	59,886,000
Widening only	429	5,659,000
Widening and Retread	48	762,000
Relocating	35	1,315,000
Adding two additional lanes	186	9,562,000
Total	4,650	\$98,227,000

The above listed estimates do not include right-of-way costs, which item is furnished by the counties in Florida.

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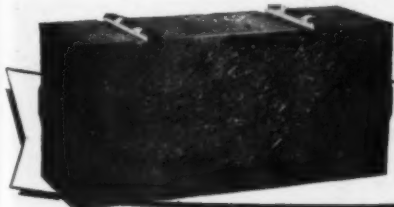
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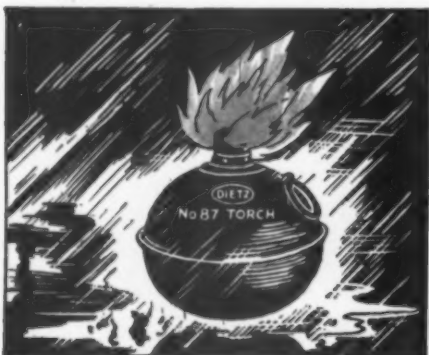
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Pidgeon Key and a Section of the 7-Mile Bridge on the Overseas Highway to Key West.

Bridge Needs in Florida.—Few defects in the road facility are more serious than a defective bridge. Like a weak link in a chain, a weak bridge can render a section of road practically unserviceable. Nothing has been more effective in bringing to notice the inadequate condition of many of Florida's bridges than the national defense program. Safe movement of heavy tanks and army equipment requires substantial bridge structures. A large number of the bridges in Florida fall short of meeting army requirements.

Of the 1976 bridges on the state maintained system, 1,046 are all timber structures. Many others are combination of timber and either concrete or steel. It is largely the older timber structures that are unsafe for heavy transport.

Immediate improvements needed on the state maintained system involve 771 bridge structures at an estimated cost of \$17,616,000. Estimated cost of the various types of needed improvements for the immediate future are as follows:

Type of Improvement	Number	Length	Estimated Cost
Widening	157	32,738	\$ 1,415,000
New construction.....	612	125,632	16,152,000
Reconstruction	2	215	49,000
Total	771	158,315	\$17,616,000

As is indicated above, most of the needed bridge improvements involve replacement of the present structure with a new one.

Administrative and Financial Policies

The tremendous back-log of capital improvements needed immediately (a total estimated to cost \$115,843,000 for roadway and bridge structures) can be attributed in great measure to the lack of necessary revenues for retirement of roads when their economic life became expended. As road building emerges from the expanding stage of development to a relatively stabilized procedure better results will be obtained from programs designed to space construction

in order that retirements will occur in periods in which the revenue for that purpose is available.

Military demands have further disrupted the normal construction program in Florida. It has been necessary to defer directly

needed projects to later periods in order that roads around military bases could be improved. Florida exerted every effort to give military demands preference over normal demands. In fact, the power to determine the allocation of new construction has been shifted from the State Road Board to the State Defense Council. As far as is financially possible, Florida will shoulder the responsibility of expediting national defense by giving preference to military roads. Yet, it should be pointed out that any extensive program of military road construction, justly, should be financed by federal revenues.

ANNUAL MEETING A.S.T.M. TO BE HELD IN CHICAGO

Some 17 separate technical sessions are being scheduled for the 44th annual meeting of the American Society for Testing Materials to be held at The Palmer House, Chicago, during the week beginning June 23 and extending through Friday, June 27. This number of sessions is necessary for the presentation of the 100 technical papers and reports and to provide time for discussion. Throughout the week of the meeting some 200 technical committees of the society are expected to meet.

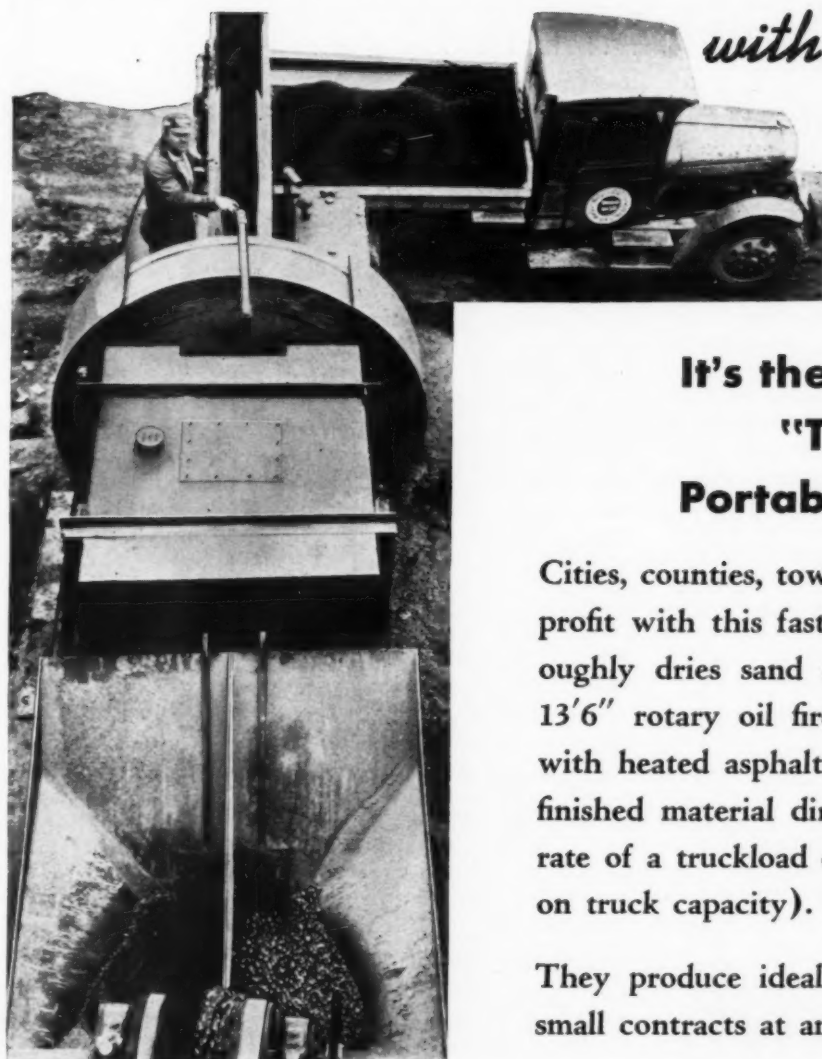
The 6th exhibit of testing apparatus and related equipment will be in progress; the society's sponsors these exhibits, every two years, at its annual meetings. There is also being sponsored the 4th A.S.T.M. photographic exhibit on the theme, "Materials, Testing and Research."

Eastern Photoelasticity Conference to Meet in June.—The 13th semi-annual meeting of the Eastern Photoelasticity Conference will be held on June 12, 13, and 14, 1941, at Cambridge, Mass., under the auspices of the Department of Mechanical Engineering at the Massachusetts Institute of Technology. All inquiries should be addressed to W. M. Murray, Room 1-321, Massachusetts Institute of Technology, Cambridge, Mass.

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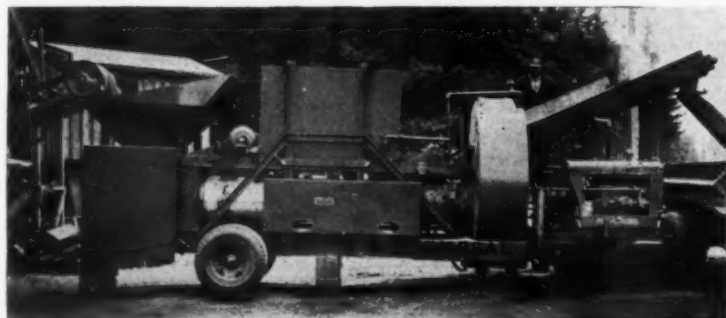


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Highway Future Dark in Georgia.

Heroic Measures Needed

By CRLOGI

Atlanta, Ga.

PITY, patience, and long-suffering sympathetic cooperation are the only sins which can honestly be charged to the Public Roads Administration for its imposition of a \$504,074 diversion penalty against Georgia, one is forced to believe after investigating the circumstances which led to the third penalty imposed against a state under the seven year old penalty clause of the Hayden-Cartwright Act of 1934.

This conclusion is emphasized when it is realized that the penalty was less than half what it might have been and that every opportunity was given the state to get its house in order before Thomas H. MacDonald, Com-

missioner of the Public Roads Administration, personally, deems wise.

There is little wonder that Congressman Wilburn Cartwright, of Oklahoma, Chairman of the House Committee on Roads, declared in Atlanta last year in an address to the Association of County Commissioners of Georgia that Georgia's highway finances were handled worse than those of any of the other forty-eight states in the Union. He had every reason for such a belief. Here are some of the things he must have known:

1. In the last fiscal year, which closed June 30, 1940, Georgia diverted more than 24 percent of her motorists' taxes to schools.

2. Though she had an income from gasoline taxes and motor vehicle registration fees of \$23,640,000, the total income of the highway department from the state treasury was only \$14,240,202!

3. Though state construction was started in 1916 on a state system with a total of 4,800 miles, the system has been added to until it now consists of 11,706 miles, of which only 6,100 miles have been completed. That means 48 percent of the system is still incomplete.

4. The minimum estimate for rebuilding antiquated, crooked, narrow roads and criminally inadequate bridges on the state system is \$20,000,000.

5. Operations of the highway department in the state have been drifting into an enormous deficit, growing from a deficit of \$2,961,553 in 1933 to \$12,067,275 at the close of the fiscal year on June 30, 1940 and to more than \$18,000,000 when the new administration took over the affairs of the state on January 14, 1941.

6. The financial position of the highway department became so bad in the late summer of 1940 that estimates for work done by contractors during August and payable September 25, were not met, nor were succeeding estimates paid, while materials and equipment suppliers have met a similar fate. Naturally, jobs were shut down, work stopped on even Federal Aid projects, and paralysis hit Georgia's highway program.

7. Now, an effort is being made to settle the \$18,000,000 deficit with non-interest bearing certificates of indebtedness running from one month to three years with creditors forced to carry them or discount them at banks at a shocking rate of three percent per annum.

Oak From Acorn Grew

Is there any wonder that Federal Aid had to be stopped and that a penalty was imposed against such handling of the finances of the department? That the penalty had not been imposed before was only due to sympathetic consideration by the federal bureau.

The situation has not grown over-night, of course. Like so many other states which have started mismanagement of highway funds in a small way, Georgia's



missioner of the Public Roads Administration recommended action which was taken on January 1, 1941.

Repeated warnings, frequent conferences and sincere pleadings were to no avail, however, and with a state legislature coming in with a new administration pledged to a program which would evidently require other diversions, the penalty was imposed.

Yet, despite the penalty, Georgia's Governor Eugene Talmadge, made no recommendation to his legislature which would relieve the situation, but instead sponsored a so-called budget control bill which has the effect of throwing all the state's income into a common pot for

deplorable condition had a modest beginning, but has grown in ever-increasing leaps.

Georgia adopted her gasoline tax in 1921. It was, of course, understood that all revenue would be used for building roads. It was not until 1929 that diversion first raised its ugly head in the state. A one cent in-



crease was put onto the four cents already collected, to be allocated to the common schools of the state, and another cent added for maintenance of county roads. That was before the effective date of the Hayden-Cartwright Act, of course, and had nothing to do with the penalty. But, this first step pointed the way for a constant stream of efforts to increase legislative diversion, which reached its peak in the session just closed. Now, there are no highway funds in Georgia other than what the Governor, as Director of the Budget, may set up. If he chooses to stop highway work entirely, he may. THE ACME IN DIVERSION HAS BEEN REACHED IN GEORGIA!

The first bill on the calendar of the recent Legislature in Georgia, which adjourned March 22, after a seventy day session, was the Governor's budget control bill. Its provisions were innocent enough on their face. It stipulated only that the Governor could take whatever surpluses might occur in a department at the end of each quarter, place these monies in an emergency fund to be spent as he deemed best for the interests of the state. On the face of it, there was no serious harm done. But, the joker in the legislation was that as Director of the Budget the Governor determines how much of its allocated funds a department may spend during a quarter, thereby creating such surpluses as he desires. That's where the different light comes onto the picture. Let's take a look at the deficit built up by the highway department and the financial position of the department which must be overcome.

There has always been a tendency in Georgia for an administration to seriously overspend during its last

year in office and to leave a deficit to be overcome by the incoming administrators. The highway department was set up as a separate corporation to keep it out of politics, but that intention was forgotten so many years ago that many do not know it ever existed.

Under the law which made the Governor the director of the budget he became a director of the state's financial affairs which placed him in absolute control of the supposedly non-political highway department.

Furthermore, terms of office of highway commissioners were supposed to be six years, with each governor who came in for a two year term getting to appoint one commissioner. That little idea blew up too, when each succeeding governor would have the legislature pass a bill discontinuing the highway department and setting up a new one, which allowed him to appoint his henchmen to all three places on the Board. How such procedure has made the highway department of Georgia a political football is easy to understand.

The winter of 1939-40 was the most severe Georgia has had in many years. Untold miles of improperly laid surface treatment roads froze and spewed and began to wash away. This emergency repair situation was taken over by state forces. Roads were retopped with a hot mat of sand asphalt bought from privately owned plants. So much rumor and speculation followed the issuance of purchase orders on this work that a federal investigation of state affairs was begun early in the summer of 1940, resulting in several indictments and a conviction in the only case tried to date.

Regardless of the findings of this investigation the fact remains that a budget of \$450,000 was set up for the state forces. Yet expenditures up to June 30, 1940, ran to \$4,089,000.



An equipment budget of \$200,000 was set up yet payment on equipment totaled \$2,718,000.

Though the fiscal year 1940 ended with a deficit of slightly more than 12 million dollars, even a court injunction could not stop the spending and another six million was added during the next seven months.

"Stiff Tickets" Issued

Meanwhile the purchase of equipment and laying of asphalt by the state forces was taking such an enormous portion of the revenue that there was no money to pay on contracts after August 26. Contracts on federal aid projects received the fifty percent furnished by the federal government but contracts on state aid work were left with the contractors "holding the bag."

Certificates of indebtedness for these unpaid estimates were issued by the last administration, carrying seven percent interest from the date of the estimate until redemption, but no due date was put on them and the



banks refused to accept them. Finally, the new administration abrogated them and ordered new ones issued which bore no interest at all but had due dates. The first of these have just been passed around and now the creditors of the state are having to discount them and themselves pay interest on the money the state owes them. A total of \$18,000,000 of these certificates of indebtedness will be issued, falling due at various dates between May 1, 1941, and October 31, 1943.

While it is planned to pay six million dollars a year on these certificates, the department will have no money for state aid work, at all. The budget calls for matching \$3,300,000 of Federal Aid funds each year to prevent its loss.

Despite motorists' taxes which will exceed \$25,000,000 per year, only this pittance of \$3,000,000 will be used on new construction work.

When the new administration came into office on January 14 it was not only faced with this \$18,000,000 highway deficit, but also with the fact that common school teachers had not received their full salaries in the year 1939-40 and there were no funds to pay them in full for the 1940-41 term. Georgia's total income, other than that received from her motorists, amounted to only \$22,304,000 last year. Yet, her departmental operations other than highway department needs ran to \$31,219,000.

A governor who had been elected on his statement

that there was enough money to operate the state already coming in, could not turn around and ask his legislature for more taxes. He had \$5,500,000 more in expenses to meet than he had legitimate income with which to meet it. By falling back on the 1c for the gasoline taxes for schools this could be cut to about \$2,000,000.

By affecting drastic economies he made up a budget which plans to use the \$3,584,000 allocated by law to the schools and then use another \$1,535,000 which will be taken from the highway funds. This will be done by calling the one and a half million dollars a surplus and putting it into the emergency fund as permitted under the budget control bill.

But how, indeed, can Georgia have a surplus of highway funds when she has to issue \$18,000,000 of certificates of indebtedness because she hasn't money to pay legitimate bills?

There is approximately \$11,000,000 of Federal Aid money now available to Georgia. She will only match \$3,300,000 which would be lost, yet Georgia has a surplus to divert to other uses!

How can Georgia have a surplus when her highways are choked with national defense traffic, when farmers and school buses are stuck in the mud, when more than three hundred people are being needlessly killed on her highways each year where their deaths are directly attributable to inadequate bridges and antiquated roads.

A citizens organization made a serious attempt in the late legislature to get a constitutional amendment submitted to a referendum of the people which would have protected the highway funds at the Hayden-Cartwright level after July 1, 1943. It was pounded at the members of the legislature that the budget control bill would bring further Federal penalties to Georgia. It was argued that even though this amendment would not become effective for two years its passage by the legislature and ratification by the people would probably forestall any penalty.

The legislature adjourned, however, without submitting the proposition to a vote in either house.

There are those who will wonder why someone has not sued the state for its abrogation of contracts and demanded cash or at least interest on the certificates of indebtedness. There's a good answer to that, however. Even though some creditors might get judgment from the Supreme Court of the United States no obligation of Georgia becomes an obligation until the Governor sets it up in the budget. A court order, therefore, would be an empty victory. Nothing would be gained. Political favor would be lost.

Georgia's highway future is indeed dark. Progress is halted. The state is in the doldrums.

The patient is extremely ill. It may take heroic measures such as the absolute cessation of highway work to effect a permanent cure.

These are some of the conditions which Georgia faced and which were known to the Public Roads Administration when the penalty was imposed. These are the conditions that grow when intelligent management and supervision are missing in the handling of the state's finances. These are the tragic facts which have to be faced when a legislative body fails to take the positive position for which it alone is responsible in the handling of the state's money.

Is there any wonder that Mr. Cartwright called Georgia's handling of her highway finances the worst of all the 48 states? Can the Public Roads Administration be accused of any sin other than pity, patience and long-suffering sympathetic cooperation?



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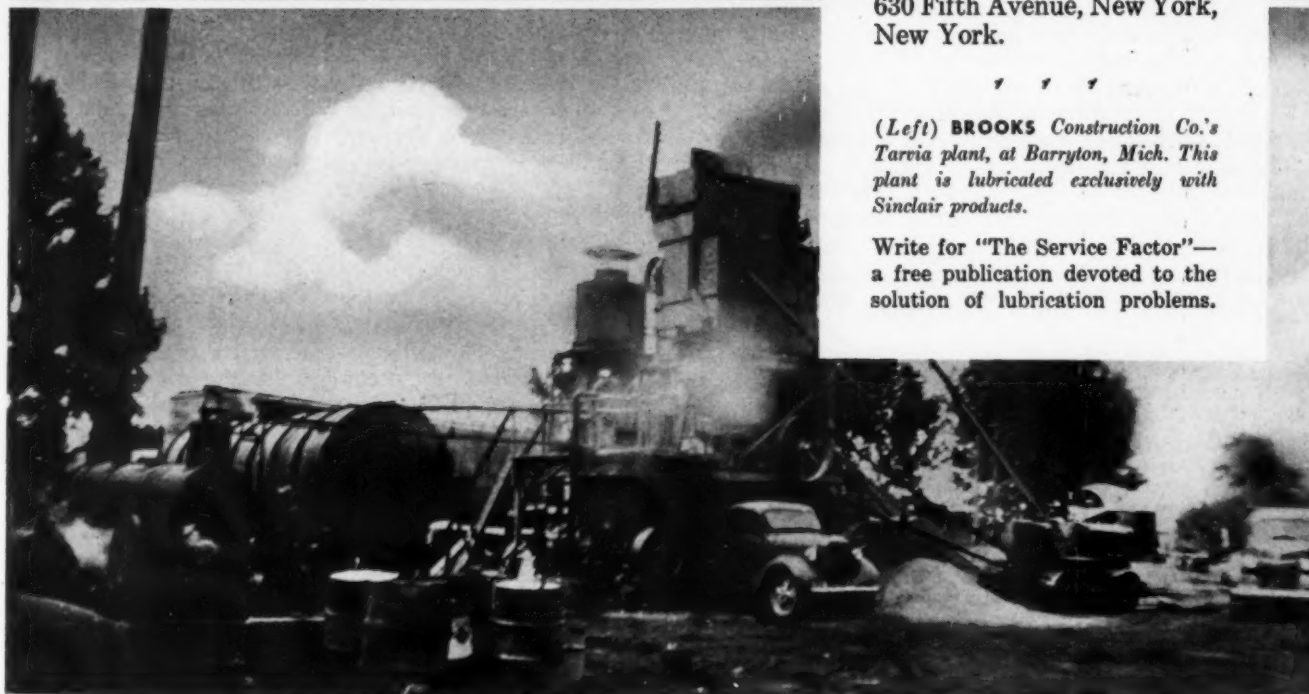
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COMPACTION OF EMBANKMENT AND FOUNDATION MATERIALS

Operation of Present Equipment as Related to Theory

By FRANK NIKIRK

Civil Engineer, Caterpillar Tractor Co.;
Chairman Sub-Committee No. 2, Soil Compaction Committee,
American Road Builders Association

DURING the past ten years much engineering thought and experiment has centered on the study of soils, their characteristics and their behavior (1) under loads, (2) in different parts of an earth structure, and (3) under varying moisture and climatic conditions. These investigations have led to the general agreement that the density of any given soil is a gauge of its stability and that most earth fills require some degree of mechanical compaction during construction. There is not, however, a universal accord on the subject of the *minimum* density that *must* be obtained for different soil types and in different parts of earth embankments.

It is generally conceded that the *maximum* degree of density that *may* be obtained depends upon, (1) the nature of the soil, (2) the degree of pulverizing and mixing of the various constituents, (3) the moisture content, and (4) the thickness of layers in which it is placed, as well as the size, type and method of operation of the equipment used in hauling, placing and compacting. It is evident that these factors in their many variations may occur in an almost infinite number of combinations. The interrelationship of these various elements points to the fallibility of attempting to seek an economic solution of the whole problem by investigating one of the factors.

The object of compaction is to obtain a sufficient and a uniform amount of solid material, as measured by its dry weight, in each cubic foot of an embankment. The chief function of moisture is to act as a lubricant during the compacting process and the optimum moisture content for a given soil varies with type, size and methods

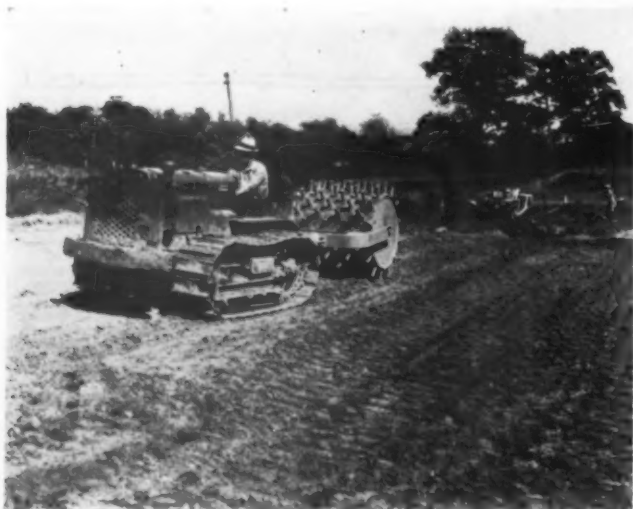


"Important Role in Soil Compaction May be Illustrated by the Action of the Modern, Large-Sized, Low-Pressure, Rubber Tires"

of application of the compacting equipment. It would, therefore, seem advisable to consider the relative economy of obtaining the required density with various methods, types of equipment and percentages of moisture rather than to restrict, within narrow limits, the amount of moisture in the soil for all methods of compacting. In some places in the arid west a strict adherence to the optimum moisture content, as at present determined, would entail a cost for water alone that would exceed the cost of excavating and placing the earth. In other localities, subject to heavy rains during the working season, moisture control between narrow limits will cause delays that are costly to the contractor and must be provided for in the price bid.

It is not the intention of the writer to usurp any of the prerogatives of the engineer or the laboratory technologist in determining the degree of compaction that should be developed. It is believed, however, that this discussion may, with all propriety, deal with some of the mechanical and economic factors that are involved in obtaining the desired result.

A review of the highway industry during the past fifteen or twenty years reveals that, in spite of a continued rise in the cost of labor and a general decline in the purchasing power of the dollar, the cost of grading on federal-aid projects has continued to decline until the average price bid during 1940 was less than half of the average price in 1922 and 1923. This decline has even greater significance when consideration is given to the increased length of hauls and added requirements for placing and compacting fills during the past ten years. There can be no doubt that this reduction of cost was due to the cooperation between the engineer, the constructor or construction superintendent and the equipment manufacturer. Such advancement in methods, equipment and management will surely justify the con-



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It's a fact that calcium chloride pays its own way in savings on maintenance and resurfacing expense. And, in addition, greatly improved traffic service is provided.

Proof of this is found in the experience of State and Federal officials on public highways, forest roads and military projects.

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tinued cooperation of these groups to the end that the necessary perfection in compacting earth fills may be obtained with the maximum economy.

It is therefore the purpose of this discussion to set forth some of the observed phenomena in soil compaction from the standpoint of the mechanical operations and the machinery used. It is suggested that a clearing house for both qualitative and quantitative data and information be established so that the work of independent investigators may be correlated and made available to others.

Machines and Mechanical Forces

There are three mechanical means of compacting soils; namely by the application of (1) weight, (2) impact, and (3) vibration. The application of weight is most effective in cohesive or slightly cohesive soils where the moisture content is sufficient to render the finer fraction of the soil plastic or semi-plastic. Impact is most effective in somewhat dryer soils of this type and in soils containing a considerable amount of angular rock fragments. Vibration has an advantage over the other methods when compacting cohesionless soils such as sand and gravel. Machines using a combination of two or more of these forces are useful over a wider range of soil types and conditions, but for the purpose of this discussion they may all be considered under the three classifications given.

Weight.—First, let us consider a loose soil mass spread over a considerable area but otherwise unconfined. Any soil, thus placed and of a type satisfactory for making a fill will have some supporting power, even in a loose state, the amount of which will depend upon the nature and condition of the soil itself. Then let us consider that a portion of that area is loaded with a weight not to exceed the supporting power of the area of contact. No compression or movement will take place. If this supporting power is exceeded, there will first be a displacement due to the lateral yield of the soil and then a consolidation of the supporting soil. Hence, the load will sink until the supporting soil develops sufficient bearing power to resist further penetration. This increase in strength is due to increased density and to the increased lateral pressure of the adjacent soil which has the effect of confining that portion under load. The



Typical Appearance of Fill Being Compacted by Large Tires on Hauling Equipment

depth of penetration or submergence of the load will depend upon the ratio of the unit pressure of the load to the initial unit supporting power of the soil and those characteristics of the soil which cause it to build up resistance under load.

Studies of soils of uniform characteristics throughout their masses have proved that when they are subjected to a uniform load over a circular area, the greatest stress occurs at a depth equal to approximately $7/10$ of the radius of the loaded area, and that the stress decreases above and below that point. This rate of decrease is sufficiently gradual for us to consider that a zone of maximum stress exists within the supporting soil, beginning at a depth equal to about four-tenths of the radius of the loaded area and extending to a depth equal to the full radius. The unit pressure applied to the soil mass below this zone of maximum stress may be of sufficient magnitude to further consolidate it under repeated loadings.

Other studies of the reactions under uniform loads applied to rectangular areas, where the length of the loaded area is considerably greater than the width, indicate that the unit supporting power of a soil increases as the width of the loaded area increases. This result is much more pronounced in cohesive soils having a high moisture content than in granular soils with a high internal angle of friction.

Similar studies of reactions under moving loads of non-uniform distribution and supported on elliptical as well as rectangular areas would throw additional light on this subject. Without such studies no quantitative data are available but it would seem reasonable to assume that moving loads would produce reactions similar in kind to those of static loads. This will serve to explain the results obtained from the action of those machines which apply relatively low unit pressures over comparatively large areas of contact.

It is the excessive unit pressure and not the total weight that causes rutting or lateral displacement of the surface of a fill. It follows then, that those machines which apply high unit pressures will disturb, displace, or loosen the soil above the depth of penetration even though they may be effective in compacting the soil below that depth. When the depth of penetration and the amount of displacement of the top layer become excessive, the amount of power consumed in churning the soil may become so great that the operation will be impractical or in some cases, may become physically impossible. This result is illustrated by the action of weighted tamping rollers and overloaded high-pressure tires on trucks when operating over plastic soils that have a high water content.

Let us consider the ordinary type of a road-roller con-



Typical Appearance of Fill Being Compacted by Tamping Roller



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Compacting Fill Approach to Bridge by Impact

sisting of one or more cylindrical rolls, by which pressure is applied to the surface traversed. Such machines were originally designed for compacting surface courses and for bases that already had a fairly high supporting power. If, however, they are applied to loose soil and especially to soil that is somewhat plastic, the rollers will push a mound of earth ahead of them until they mire down or otherwise defeat their purpose. If the soil has sufficient bearing power to support the initial trip, the width of the contact strip under the roller becomes narrower with each succeeding trip until it approaches a line and the maximum pressure is exerted at the surface. This results in a non-uniform density in each layer with the maximum at the top and the minimum at the bottom.

The tamping roller is most generally used for soil compaction in this country, although it is not effective in cohesionless sand or in rock fills. This machine had its inception about thirty years ago in an attempt to imitate the action obtained by running a flock of sheep over a loose fill—hence the name sheep-foot tamper. It consists essentially of a cylindrical drum from which prongs or feet extend. The principle of operation is that, as the drum is pulled forward, the feet penetrate the soil until bearing power sufficient for support is obtained. If the support obtained by the feet is not sufficient to carry the full weight of the roller the balance is carried on the soil supporting the drum itself. The compression of the soil directly under the feet together with the confining pressure of the adjacent soil helps to develop resistance to penetration. Successive trips build up a dense layer at the bottom which increases in thickness until on the final rolling the feet ride on the soil surface. The success of this operation depends upon the type of soil, its moisture content, the thickness of the layers, and upon the design, size and weight of the tamping roller itself.

During the past ten years much attention has been given to features of design such as the size and shape of the feet and the ratio of the length of projection from the face of the drum to the diameter of the drum itself, so that there will be the minimum disturbance of the top layer of the soil as feet are forced into it and withdrawn. The size and weight of these machines have been increased until the pressure on the foot surface has increased from approximately 100 lb. to over 500 lb. per square inch. Specifications have been written determining the number of units that may be pulled behind one tractor and the speed at which they must be operated, but the only thing that seems to have been definitely proved is that no one type or design of tamping roller is equally adapted to all soil conditions.

It would seem that the investigation of the adaptability of tamping rollers to various soil types and conditions would be a fruitful field for further research. Such a study might point to the advisability of increasing either the weight or the number of passes of the tamping roller and decreasing the moisture content below the optimum as determined by Proctor Test when compacting some soils or in cases where the cost of water is excessive. More consideration should be given to the relationship between the unit pressure applied by the feet of the tamping roller and the supporting power of plastic soils with the moisture content that is to be required. Attention should also be called to the fact that tamping rollers are generally hauled by track-type tractors and more effort should be made to distinguish between the compacting effect of the hauling unit and that of the roller. There have been cases where no additional density was developed by pulling tamping rollers over earth fills beyond that which would have occurred by pulling the same weight in any other form for the same number of trips.

The action of track-type tractors or other track-type machinery will not be discussed here. Inasmuch as such equipment involves both the principle of weight and vibration in compacting soil and since their unit pressure is low, they will be discussed under the heading of vibration. One very obvious factor must be considered, however, and that is that hauling and spreading equipment plays a very important role in soil compaction. This may be illustrated by the action of the modern large-sized, low-pressure rubber tires.

The popular conception of the action of pneumatic tires seems to have been obtained from observation of tires ordinarily used in cross-country haulage. Studies have generally been confined to the action of such tires on thin flexible road surfaces. One available record of the largest size studied (18.00 x 24.00 carrying 60 lb. of air pressure) which, when loaded to its recommended capacity, produced an elliptical area of contact on a flat firm supporting surface. The distribution of pressure was from zero at the outer edge of the ellipse to a maximum of slightly more than 20 percent above the amount of inflation. The areas of maximum pressure occurred in two elongated strips, one on each side of the center line of the tire, and may be accounted for by the amount of weight carried by the side walls of the tire. Obviously, the amount of pressure exerted upon any portion of the area of contact over and above the inflation pressure would be a function of the design of the tire, and the number of plies of cords or fabric.

Now, if this loaded tire were supported on a plastic or semi-plastic material such as an uncompacted or par-



Track-Type Tractors and Track-Type Wagons, Illustration of Compaction, Obtained by Weight Combined with Low Frequency Vibration

Stability FOR NON-TIP POURING

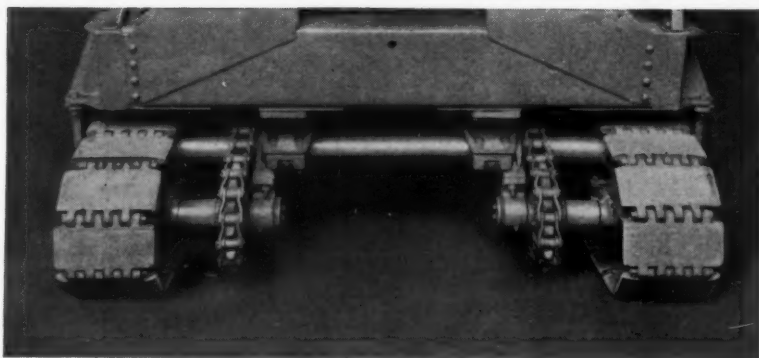


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NEWPORT, KY.

tially compacted fill we would expect a certain amount of submergence. The area of contact would increase and the maximum unit pressure would be determined by the resistance of the soil which may be even less than the inflation pressure in the tire. The construction of such a tire and its cushion of air permits an adjustment of the unit pressure applied to conform with the supporting of the soil within a considerable range above and below the inflation pressure of the tire itself.

A study of these reactions will indicate why the tire with large diameter and with large cross-section especially designed for earth moving has a compacting effect at greater depth and why it has less tendency to rut and displace the surface of the fill than did its smaller predecessor. These are two reasons why equipment mounted on modern large pneumatic tires will work economically over soft earth fills where similar equipment on small high-pressure tires would be useless. For the same reasons fills built in layers and subjected to hauling by heavy equipment on large tires require less subsequent compacting than those where similar material is placed by hauling units on small tires.

The limit of the field of usefulness of pneumatic tires can generally be gauged by their tendency to sink into and rut the surface of the fill. In all cases, it is necessary to keep the surface of the fill in a uniform condition, free from ruts or bumps, during the compacting process, if maximum results are to be obtained. Likewise, if high speeds in hauling are to be maintained, it is necessary to keep the surface of haul roads in good condition. For these purposes a blade grader or motor grader is generally used.

Impact.—In Europe several attempts have been made to develop rammers or other machines designed to utilize the principle of impact in compacting earth. One type, namely, an explosion-rammer has been tried in this country. It consists essentially of a heavy weighted cylinder in which an internal combustion engine is mounted. The force of the explosion causes it to leap into the air while the operator guides it about the surface to be compacted. This action has won for it the name of "Leaping Lena." Because of the limited area that can be covered per hour in this manner it has not proved very economical. It has produced good results, however, in compacting material used in back-filling trenches and around structures that are not accessible to other types of equipment.

The name "tamping-roller" might imply the importance of impact in their operation. Some specifications



"Vibration Is Most Effective Means for Compacting Cohesionless Soils"



Large, Low-Pressure Rubber Tires Knead the Entire Cross Section of an Embankment

defining the minimum speed at which such machines must be operated would seem to be aimed at developing impact. It would appear, however, that, within the range of speed usually attained with tractors and rolling tampers, the compacting effect due to speed is small in comparison with that attained by the high unit pressure applied by the feet of the roller.

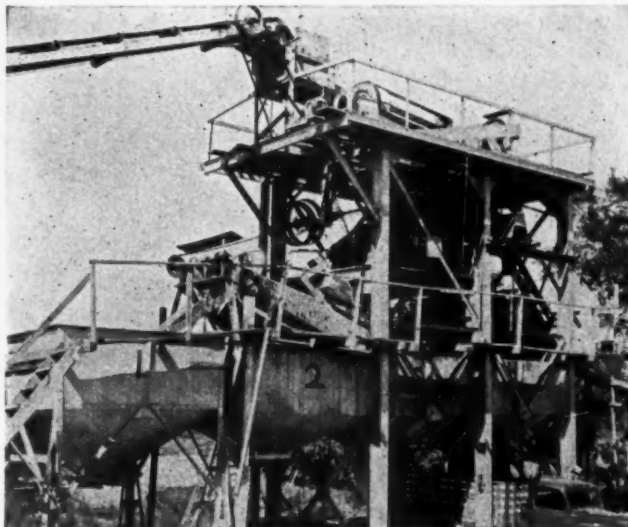
Loose surfaces on fills do not provide the best tractive conditions and it is generally the weight of the tractor rather than the engine horsepower that determines the load that can be hauled. The ratio of engine power to tractor weight in most commercial tractors is such that they can generally pull their maximum load of tamping rollers at about two and one-half miles per hour. It might be advisable to suggest a further study of the effect on the time and energy expended in obtaining a given degree of density by decreasing the number or weight of rolling tampers and thereby obtaining a higher speed of operation.

Vibration.—While vibration is recognized as an effective means of compacting soils, no machines for its use have received acceptance in this country as primary compacting units. The principle, however, is illustrated by the action of track-type tractors and track-type trailers. Such machines carry considerable weight but because their tracks provide a large area of contact with the ground surface, their unit pressure is much less than any other type of equipment of comparable size and weight. Because they operate over jointed tracks they set up a vibration in the soil in a manner not equalled by other types of hauling equipment. Since track-type tractors, operating without accessory equipment, have proved very successful in compacting earth embankments where the effect of vibration was most desired, their functions and operation will be discussed under this heading.

Let us consider the compacting of a granular soil as the act of readjusting the position of the soil particles in relation to each other so that the finer particles slide into the voids between the larger ones, thus causing the mass to occupy less space. That is, the function of vibration and the element of time required for the particles to readjust themselves has (for want of a better term) been called the "soil lag."

Vibration is the most effective means for compacting cohesionless soils such as sand and gravel and is also effective in soils composed of a wide range of particle sizes with some moist cohesive material so as to compare in consistency with a concrete mixture having a very little slump. In such soils vibration increases the density

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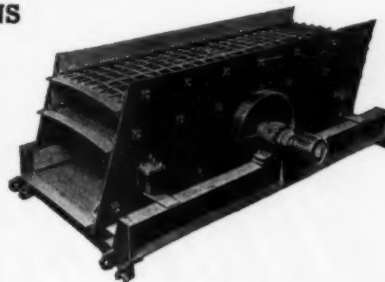


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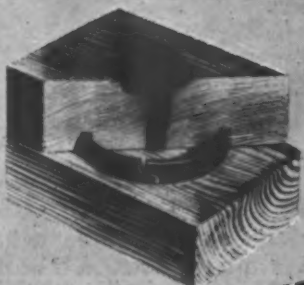
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to a much greater depth than does the application of weight only.

Track-type equipment applies a load combined with vibration during that interval of time required for the machine to travel the length of the ground contact. This provides for the soil lag. Tractors, when developing a drawbar pull at or near the maximum that tractive conditions will permit, will develop a slight slippage that causes a troweling action which helps compaction near the surface. The unit pressures developed with this type of equipment are less than for other kinds and the wide area of contact develops resistance in plastic soils. For these reasons such equipment will function under conditions that would render other types useless. This reduces to a minimum the delays caused by soil or weather conditions and the added cost resulting therefrom.

In many cases material, hauled by this type of equipment and spread in layers over which subsequent loads are hauled, develops sufficient density to resist any future settlement. Practically all types of soil, when thus handled, will require less subsequent compaction to obtain the desired density. The maximum compacting effect of hauling equipment results when the various hauling units are routed over different courses on successive trips so that the whole area of each layer receives, as nearly as possible, the same treatment. The depth to which the compacting force of track-type equipment is effective causes an increase in density in layers below the one traveled on and tends to produce a fair degree of uniformity in the fill even when the distribution of the loads over the entire area of each layer is not entirely uniform.

Special Conditions and Specialized Equipment

Highway embankments are generally made of materials obtained from cuts or from adjacent borrow areas and the selection of soils for their uniformity and suitability is practiced to a very limited degree. For this reason, a wide range of soil types and conditions may be encountered on any road project of considerable length. It is impractical to select specialized equipment for the handling of each type. Therefore, it is highly advisable to adopt methods and practices that will permit of the use of a minimum number of kinds of construction equipment as well as to select equipment, that has the widest range of utility. While these rules apply particularly to excavating, hauling and placing material they should also be considered in reference to the compacting.

After these various soil types have been placed in the fill they may be subjected to seasonal changes in moisture and temperature and to different loading according to their position in the structure. In that portion at or

near the top of the fill and especially under flexible surfaces, the effect on concentrated moving loads will be much greater than that of the static load. As the depth below the surface increases the effect of the moving load decreases and the effect of the weight of the superimposed fill increases until at the bottom of high embankment special attention must be paid to obtain stability against the static load.

Upper Zone in Embankment.—It is the middle zone, between the portion which carries the concentrated moving loads and the lower zone carrying great static loads, that forms the greatest volume of highway embankment and requires less special treatment than the others. The upper zone not only carries the traffic loads but is also more subject to seasonal changes in stability. This often calls for special treatment either by placing selected material in the top of the fill or by some form of subgrade stabilization. In any case, it calls for a layer of uniform supporting power and uniform stability.

In any type of stabilization, the object should be to obtain a layer of uniform thickness and uniformity should be the watchword in all the operations of proportioning, mixing and compacting. For processing the soil, the engineer first turned to agricultural implements such as heavy spring-tooth harrows and disc harrows. With slight modifications these tools are still widely used.

While such implements are not strictly compacting machines, their operation is preliminary to compaction and they materially aid in obtaining density and stability. Their action therefore should be considered. Since they were developed as agricultural tools it would seem that further investigations and tests might result in improvements that would increase their efficiency in soil mixing. One needed improvement is some form of depth gauge or method of control of the penetration in various soils.

Since disc rotation is an important factor in mixing soils with disc harrows more should be known about the effect on rotation caused by the concavity of the disc, the disc angle with reference to the line of travel and the speed of operation in various types of soil. It is generally considered that the rotation of the disc is retarded when the depth of penetration exceeds approximately one-third the diameter of the disc. This limits the thickness of layers to about 10-inches when greatest efficiency is desired with present day disc harrows.

More information should be made available regarding the size and shape of spades for spring-tooth harrows to obtain the best mixing results in various types of soil. Machines of this type as they are now built are also limited to a penetration of not more than 10-inches.

When the depth of the course to be stabilized is



The Rubber Tired Roller "Has Proved Very Successful in Finishing the Top of Foundation Courses"

greater than 10-inches it is advisable to treat it as two layers, each being mixed, spread and compacted separately. Blade graders and motor graders are used to loosen the surface if treatment is to be given to the surface layer of a fill that has been compacted. They are also an aid in pulverizing and mixing. The compacting is generally accomplished by sheepfoot tampers. These machines generally leave a thin layer of uncompacted soil which must be bladed off to form a part of the surfacing material or must be bonded into the foundation by a smooth road roller or by a rubber-tired roller. This latter machine has proved very successful in finishing the top of foundation courses on which thin flexible pavements are to be laid. Its action may be attributed to the rubbing or troweling action caused by the flexing

of the tires. There is not enough known regarding the proper weight, size of tire and inflation pressure to obtain the best results.

Conclusion

This discussion, which was prescribed as a Committee report at the last convention of the American Road Builders' Association, appears to be more of a narrative of what we do not know than of what we do and is, therefore, evidence of lack of progress. By focusing attention on this subject it is hoped that present equipment may be used more advantageously, improvements may be made in present machines, or new machines may be developed to the end that greater economy may result in the compaction of earth embankments and foundations.

POWERS' CATALOG COLUMN

THE seventeenth annual edition of *Powers' Road and Street Catalog* was published in mid-April, and for the next eleven months will stand as the primary source of reference for many thousands of purchasers of highway materials and equipment.

Some Features

The 1941 book is a distinct advance over its predecessors in that six classes of equipment have been added to the comparative specification tables; while the section devoted to miscellaneous data has been increased to nearly seven times its size in 1940.

This data section, by the way, brings together more time-saving tables for highway builders and maintainers than have ever before been presented in one place. Most of them can be found elsewhere; but only by turning to many sources; and as time-savers, they lose value when they have to be hunted for. Turn to the back part of Powers' Catalog next time you want a short cut to a quantity calculation, a weight or volume conversion, or a condensed specification.

A Correction on Road Tar Specifications

Through a printer's error, the introduction to the table of tar specifications on page 275 is a repetition from our issue for the year 1938. It should have stated that these specifications are the standards of the American Association of State Highway Officials in effect March 1, 1941. They were not obtained from any of the manufacturing companies; and they differ in important respects from the specifications of 1938.

We suggest that you mark out the entire introductory note as printed, and write in a memorandum that the table gives A.A.S.H.O. standards as of March 1, 1941.

Equipment Changes

The equipment specifications date in some cases from March first of this year and others from April first. Changes in these may, of course, be made at any time, and for the convenience of catalog users we shall list such changes in this column of *Roads and Streets*

as promptly as possible after the manufacturer announces them. The first will appear in next month's issue.

Service

Among other current developments is the Powers' service department. We have always supplied certain information on request, but this year we are more thoroughly organized to take care of inquiries for the names of manufacturers of equipment and materials, or to secure specific information on products. Our 1941 catalog contains prepaid postcards for this purpose.

Let's Get Acquainted

In the course of a year we meet a lot of folks, but never enough. Our chance of meeting you, for instance, is rather slim, considering that there are several times ten thousand of you. But if we aren't lucky enough to meet you personally, please remember that we always welcome letters. And they don't have to be complimentary letters; we like that kind, of course, but an honest panning may be worth more.

Just to complete our side of the introduction, here we are:



Nan S. Powers Publisher

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Mr. Heacock became connected with the tractor industry in 1919 when he joined the C. L. Best Tractor Co. of San Leandro, Calif., as auditor. He found his duties were manifold, for he served at one time and another in the various branches of reorganization work as credit manager, purchasing agent, parts and service manager.

When the Best Co. and The Holt Manufacturing Co. of Stockton, Calif., joined to form Caterpillar Tractor Co. in the early part of 1925, Mr. Heacock was named "Caterpillar's" secretary. Later he was elected first vice-



B. C. Heacock At His Desk in the Office of the Caterpillar Tractor Co.

president, and in June 1930, when R. C. Force became chairman of the executive committee, Mr. Heacock, at the age of 41 years, was elected president of the company.

When principal manufacturing was transferred to the more centrally located Peoria, Ill., factories, Mr. Heacock, his wife and daughter, Miss Helen Heacock, took residence there. The executive gives liberally of his time to the community's civic affairs, and has been honored with election to the Board of Trustees of Bradley Polytechnic Institute of Peoria.

Mr. Heacock's activities in forwarding middle west industry and his popularity among executives nationally, have brought him considerable prominence. The former resulted in his service for two consecutive terms (1936-1937 1937-1938) as President of the Illinois Manufacturers' Association.

Mr. Heacock serves the Farm Equipment Institute, national educational organization of farm machinery manufacturers, as a member of the executive committee, and the Chamber of Commerce of the United States as a vice-president. He also was a member of the board of directors of the National Association of Manufacturers, but resigned this position upon his recent appointment to the War Department.

The late Governor Henry Horner appointed Mr. Heacock a member of the Advisory Council, Illinois State

Employment Service, in June, 1935. Two years later the former governor named him to the State Sanitary Water Board. On Nov. 15, 1940, Mr. Heacock was elected a member of the Board of Directors of the Illinois Central Railroad Co.

WESTERN ASSOCIATION OF STATE HIGHWAY OFFICIALS 20TH ANNUAL CONVENTION AT CASPER, WYOMING

The Western Association of State Highway Officials will hold its annual convention June 17, 18, 19, and 20 at Casper, Wyoming. Frank Kelso, superintendent of the Wyoming State Highway Department, advises that plans are rapidly taking shape for the meeting, which is believed will be one of the most constructive and enjoyable ever held by the organization.

At this convention, which is the 20th anniversary of the organization of the association, recognition will be given past presidents and honorary members, all of whom, have given generously of their time and efforts in promoting closer relations, and the exchange of much valuable information throughout the association, resulting in a more uniform system of better highways and traffic regulations in the western states.

The Western Association of State Highway Officials comprises the State Highway commissioners, highway officials, and local representatives of the U. S. Public Roads Administrations in: Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Texas, Utah, Washington, Wyoming, Alaska, and Hawaii. Burton G. Dwyer, State Highway Engineer of New Mexico, is President, C. F. Seifried, Chief Engineer of the Wyoming State Highway Department, is Vice-President; C. P. Humphrey of Boise, Idaho, is Secretary-Treasurer.

Some of the problems of vital importance to be studied at this meeting are: "Highway Safety," "National Defense Roads," "Motor Vehicle Taxation," and "Compaction of Highway Embankments."

The program committee is composed of: C. F. Seifried, Chairman; Doctor L. I. Hewes, Chief, Western Region of the Public Roads Administration, San Francisco; and W. R. Hutchins, State Highway Engineer of Arizona. John L. Simmons, Manager of the Wyoming Highway Planning Survey, is in charge of Registrations. J. Roland Carr of the Wyoming Highway Bridge Department is Publicity Chairman.

JOBS FOR MEN OVER 40

Many a business pronouncement is being cast into the discard by the defense program. The one that a man over forty is too old for employment is giving way to the recognition that nothing takes the place of experience. The demand for older men with executive or supervisory ability is increasing, according to Chicago's Men Over Forty Club. To prepare for this demand, the club is issuing a Bulletin containing backgrounds of present members. Some of these men qualify for road construction, material and machinery sales, accounting, and other departments of contracting and manufacturing. A free copy of the Bulletin may be had by writing Men Over Forty Club, 41 North Canal St., Chicago, Ill.

The Chicago club is one of 32 chapters located in larger cities. These chapters are made up of men who have been executives, and who have records of accomplishment. They check references and the candidate's standing in his field, and accept only a small number of those making application for membership. The clubs have earned the approval of most civic bodies. Being cooperative, no charges of any kind are made.

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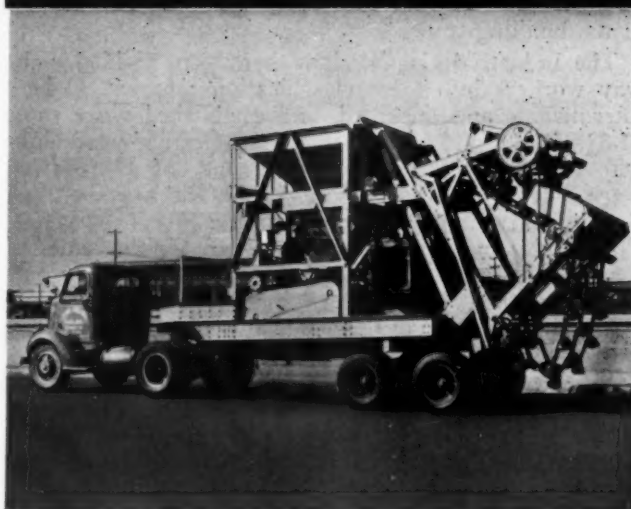
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EDITORIAL

THE CASE OF POLITICAL JUDICIAL DECISIONS or WHEN IS A CONTRACT NOT A CONTRACT?

TALKING about messes and mixups, that wage rate controversy in Colorado is about the most idiotic mess into which the courts have thrown highway construction work that the writer ever learned about. Chief Engineer Vail has the maneuvering of the unions and the courts pretty well in hand, though, it appears.

The statute books of Colorado contain a prevailing wage provision, under the terms of which if the contracting officer is unable to adjust disputes as to wage rates, the matter is referred to the Industrial Commission for final determination.

For a number of years the building trades' unions have contended that the wages prevailing in the agreements between them and building contractors constitute the prevailing wage rates, and that the Industrial Commission should establish such rates as the minimum prevailing wages for highway work.

In March, 1939, the Industrial Commission, acting upon a complaint, conducted a hearing over a period of three weeks, and acting upon what it said was the preponderance of evidence, established a highway wage rate less than the building trades' union rate. The Commission found:—"That what might be termed a skilled carpenter or painter used on highway construction work, does not require the same degree of skill as a like classification in the building trade."

The Industrial Commission, thereupon, divided highway workers into three classifications; to wit, skilled, intermediate and unskilled, and established wage rates of \$1.25, 80c, and 62½c per hour respectively for highway work within the city and county of Denver;—a wage rate of \$1.10, 70c, and 55c in the area between the city and county of Denver and the 15-mile zone outside the city, measured from a focal point in the center of the city;—a wage rate of \$1.10, 70c, and 50c, respectively, for the balance of the State of Colorado. Union labor has constantly contended against the highway wage rate established in the city.

Recently, the state highway department, acting upon the wage rates established by the Industrial Commission, advertised, received bids, and made a verbal award of a contract for the construction of a \$366,000 cloverleaf underpass just north of the city in the area termed "15-mile zone," with wages at \$1.10, 70c, and 55c. Labor contended that these were not the prevailing wage rates, in that it had just completed negotiations for \$1.43½, \$1.00 and 71-2/5c in the construction of a defense ammunition plant, also in the 15-mile zone.

It is striking to note that the scale accepted by the unions for the construction of the defense plant was a scale established by the U. S. Department of Labor as the prevailing wage rate. It is also important to note

that the contract for the cloverleaf job contained a special clause, written into it particularly by Chief Engineer Vail, to the effect that the contracting parties understand that the scale of wages established by the Industrial Commission shall be the prevailing wage rate.

On the day following the receipt of the bids, the unions protested to the state highway engineer, who advised the unions that their protest was *too late* (a statute governs this point), in that a verbal award of the contract had been made. The unions thereupon sought an injunction in the district court. The findings of the court are unique. They were:

(1) That a dispute as to the wage rate scale existed before the receipt of bids, before the award of the contract, and in fact, over a long period of time;

(2) In view of the dispute the matter was remanded to the Industrial Commission for formal hearing and determination of the prevailing wage rates;

(3) That a valid contract existed between the contractor and the state highway department, and that under the terms of the contract, the contractor could proceed with the purchase of materials and supplies, but that he was enjoined from beginning labor operations on the project until April the 1st;

(4) That the Industrial Commission shall certify to the court its determination as to the prevailing wages, and that if the court found the same to be in excess of those upon which the contract was based, the court would modify the contract to provide for the higher wages and to provide that the contractor would be reimbursed for the additional cost.

What bothers the writer is a fair question that could be asked at this point: "When is a contract not a contract?"

It so happens that this job is a grade separation project. These projects are built with federal funds and not with state funds. The job is more, even, than a federal aid job, it is totally federal with the state merely doing the engineering.

The writer wonders what authority a Colorado district court might have over a project built by federal funds. Also, the writer wonders what authority a judge has to alter a contract. He can interpret what is meant but the writer fails to see how he can possibly change its terms.

The attorney general, acting for the state highway engineer, has appealed the decision to the supreme court. The state highway engineer contends that the court has no authority to modify its contract. The contractor, on the other hand, contends that it was the responsibility of the state highway engineer to establish the actual prevailing wage rate, that if the wages advertised were less than the actual prevailing wage rates, he (the contractor) is entitled to an adjustment of the contract.

In the meantime, the Governor intervened, stating that it is the responsibility of the contractors and the labor unions to settle their dispute. The Governor con-

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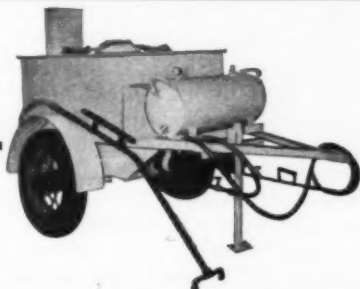
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tends that after he has approved a project, based on a certain wage scale—in protection of the public interest, the wage scale should not be modified. The Governor has threatened to withhold approval of new contracts in the Denver area until the dispute as to wages has been settled. The contractors contend that the responsibility for establishing wage scales rests with state officials, and that their only interest is in a predetermination upon which they can base their bids.

Recently a minimum wage scale bill was passed by both houses of the legislature. Governor Carr signed it the middle of April. The labor unions presented bitter opposition. Incorporated into the bill are the minimum wage scales that were established by the State Industrial Commission in 1939, the same as those given herein. This action by the legislature should settle the difficulties for at least another two years. But will it?

Future advertisements for bids on state highway work will state that the minimum wage rates established by statute will prevail. That will have no meaning for labor unions. They are not financially responsible in any way, shape, or form. They'll probably tell a contractor to go ahead and bid off a job, let him get fairly started, and with concrete on some structure about half poured will strike. Why not, they will say, it's no skin off the "back of their laps." They have no financial responsibility. What do they care who gets hurt?

In the meantime the clover leaf job still has an injunction in legal effect. Undoubtedly the Supreme Court, at its pleasant leisure, will make some statement regarding its attitude as to whether or not the lower court can modify a contract.

The unions, in the meantime, are letting the highway department and the contractors battle it out. What a mess!

The sad feature of this whole crazy quilt mixup is that the public is in the middle.

Why does the contractor do the legal battling? It seems to the writer that he, also, is in the middle or worse yet, out on the end of limb that is being sawed off. The dispute is a controversy between the federal government (whose scale was adopted by the unions) and the Colorado Industrial Commission. If the writer were the contractor he'd ignore the injunction and proceed with construction. Why should he spend his hard earned cash for legal fees to support a union started argument? Furthermore, the writer has always had difficulty understanding why a union is allowed to exist without being financially sound so that it can sue and be sued. There is no reason why, on state highway work in particular, that one man should receive more income for his labor because his hair is one color than another man should receive because his hair is not the same color.

The outcome of this hodge-podge of judicial politics is going to be a case "for the book." No matter what happens, it is a fair guess to say that both the public and the contractor will be the losers, and I mean financially.

AFFILIATE I. T. E. WITH A. R. B. A.

IT HAS always seemed strange to the writer that the Institute of Traffic Engineers were not affiliated with the American Road Builders' Association. The work of the members of this group is that of an engineer. They are included under the heading, "operation of streets and highways." Operation is one of three main subdivisions of highway work which constitute the frame-

work on which road service is hung. The other two are construction and maintenance.

The work of traffic engineers is so closely allied and interwoven with the work of construction and maintenance engineers that they should be grouped with these men. Consequently, they should affiliate with the American Road Builders' Association and hold their annual meetings in cooperation with the construction and maintenance groups.

It is the duty of the traffic engineer to expedite traffic on streets and highways. Of course they must study traffic safety and provide for safety to both pedestrians and motorists as well as they can with conditions and funds available. Too many administrators of traffic safety impose rules and laws to regulate safety rather than using their time to study for the causes for lack of safety. They put a number of motor patrolmen on the roads and imbue them with the old police theory of arrest for violation and of "hold 'em in place." Motor patrolmen should be welcomed by motorists, not shunned by them. They should be traffic expeditors rather than traffic arrestors. The writer believes that by affiliating with engineers who design, construct, and maintain the roads and streets, the Institute of Traffic Engineers will get a different and more fundamental viewpoint of their own work.

WHY NORMAL EXPENDITURES SHOULD NOT BE CURTAILED

WE ARE being urged by the President and many others to decrease our normal expenditures in order to finance production of military and naval equipment. This policy seems to be based on the fallacy of reasoning in terms of money rather than in terms of men. Until we entered upon our defense program, about 20 per cent of our normal number of workers were not engaged productively. It has never been suggested that much more than 20 per cent of our workers will be needed in executing the defense program. Hence it follows that if we put to work on defense 20 per cent of our total population capable of working, we shall be able to continue our previous per capita expenditures for luxuries as well as for necessities. Of course many of those who have been on relief are not capable of serving as producers of defense equipment, but they can replace men who are capable of that sort of work.

This leaves only one argument in favor of curtailing normal expenditures, namely that, by so doing, wage and price inflation can be prevented. However, there is no economic evil in moderate increases, provided that they do not become greatly unbalanced. During the last World War, both wages and commodity prices doubled. Yet economic welfare in America reached a level higher than ever before. We are not advocating a doubling of wages and prices again, but we do contend that if it occurs it will not be calamitous; whereas it would be calamitous if every one were to reduce his normal expenditures some 25 per cent, as is being advocated.

Finally it should be pointed out that, by the aid of applied science, American per capita productivity increases about 20 per cent every 10 years. During the 10 years of depression between 1930 and 1940, American scientists, inventors, engineers and executives added 20 per cent to the productivity of the average worker. So all of us can now "cash in" on this achievement of the brain power of the nation by putting to work all those previously on relief. And at the same time we need not, and should not, curtail our normal expenditures.

MANY HIGHWAY BILLS BECOME LAW

Special automotive taxes, fees and diversion of highway funds to non-highway purposes are receiving a major share of attention in the 43 state legislatures meeting in regular sessions this year, according to a survey of state laws already enacted in 1941, released by the National Highway Users Conference.

This information is contained in the first of a series of "Laws Bulletins" which the Conference publishes periodically covering state and Federal enactments of legislation affecting highways and their use.

Laws governing the sizes and weights of motor vehicles, regulating commercial highway transportation and motor vehicle reciprocal agreements, as well as highway financing, are of major importance among the 251 new statutes listed in the survey.

Oregon and West Virginia adopted legislation submitted to a vote of the people a constitutional amendment to require that all special automotive taxes be spent for highway purposes. The Iowa legislature took a final action on a similar proposal.

Indiana repealed a controversial tax based on tire weight and substituted a schedule of increased license fees for trucks. North Dakota and West Virginia passed laws extending the 1 ct. per gallon "emergency" gasoline tax in those states. South Dakota, Tennessee and Utah passed laws taxing diesel and other motor fuels at the same rate as gasoline.

Paramount among laws enacted this year regulating sizes and weights of motor vehicles is the Texas statute repealing the 7,000-lb. load limit and substituting a gross weight of 38,000 lb. for trucks. Tennessee increased its legal weight for trucks from 24,000 lb. to 30,000 lb., and the Indiana legislature increased both the legal weight formula for trucks based on sizes of tires instead of the former axle weight regulation.

Unique among state motor vehicle size and weight laws is a South Dakota statute which permits over-size and over-weight truck operations to communities abandoned by railroads. This is a reversal of the principle embodied in the former Texas law which allowed trucks to carry double cargo weight when operating to or from railway stations.

Oregon and Wyoming legislatures adopted laws liberalizing the motor vehicle reciprocal provisions in those states.

Arkansas' highways bond refund-

ing act attracted attention in national financial circles.

Arkansas also enacted a law regulating itinerant merchants over the highways, and Wyoming passed a statute further taxing the movement of motor vehicles in caravans.

The National Highway Users Conference estimates the laws covered in this digest, dated April 15, are the outgrowth of the introduction of between 2500 and 3000 different bills on these subjects. Indications are that more than 10,000 bills affecting highway transportation and related industries will receive the attention of state lawmakers.

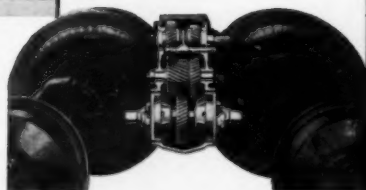
Highway Accident Property Damage Averaged \$8,000 per Day.

—During the first three months of this year nearly 5,000 accidents were reported on the 10,000 miles of Indiana state highways, including routes through cities, with 154 persons killed, 2,409 persons injured and with property damage amounting to nearly three-quarters of a million dollars. These figures do not include fatalities, injuries and property damage resulting from accidents on county roads and city streets, which are not a part of the state highway system.

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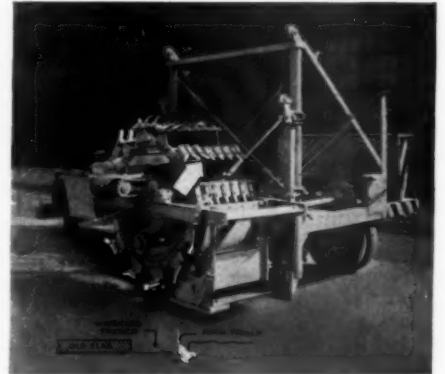
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NEW EQUIPMENT and MATERIALS

New Buckeye Road Widener Digs Widening Trench and Form Trench Simultaneously

The Buckeye Traction Ditcher Co., Findlay, O., has announced the development of a new digging wheel for Buckeye road wideners which is designed to excavate trench for forms simultaneously with the excavation of subgrade widening trench. This is accomplished by equipping each bucket on the digging wheel with two rooters which are somewhat larger and longer than other rooters on each bucket. These can be seen in the accom-

panying illustration. The diagram shows the type of trench prepared by this machine. All models of Buckeye road wideners can be equipped with rooter teeth for preparing form trench when desired. Buckeye road wideners are built in three models: 16-R-2, for digging subgrade widening trench up to 33 in. wide in one cut; Model 16-R-4, for digging trench up to 48 in. wide in one cut; Model 16-RD-4, equipped with rear dump conveyor for carrying excavated material to the trucks following the machine. (Other models discharge onto the shoulder.) These machines are de-



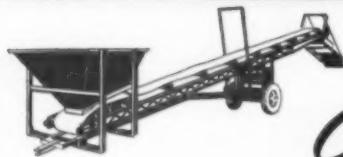
Sketch Showing Type of Form Trench Buckeye Road Widener Equipped for Digging Form Trench

signed to prepare a mile or more per day of accurate trench adjacent to old road surfaces. These machines are also used for excavations on the inner side of sharp curves where the radius is to be increased. The manufacturer will supply literature and complete information upon request.



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New Power Control Unit Line

A complete line of single and two drum power control winches for operating cable-controlled equipment with International TracTractors and other tractors has been announced by Bucyrus-Erie Co., South Milwaukee, Wis. In the new Bucyrus-Erie planetary-drive winchclutch and brake drums are separate and each drum has but one heat-generating surface; bands are external and contact 93.8 per cent of the full circumference of the drum, spreading friction pressures over a large area so that less heat is generated at any one spot. All bands and drum friction surfaces are exposed to open air to assure prompt heat dissipation. Thus, say the designers, heat is carried off before it can build up to temperatures which would damage linings,

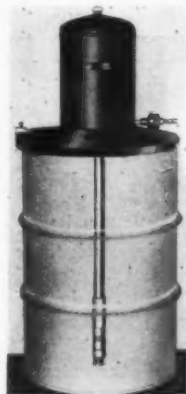


New Bucyrus-Erie Power Control Unit

ruin oil seals or cause excessive expansion and contraction with its resulting effect on clutch and brake adjustment. The wide, large-diameter external clutch and brake bands are interchangeable. One handy-to-reach adjustment on each band, in full view of the operator, compensates for wear. Bands are easily replaced in the field with ordinary tools, and without disturbing a single oil seal or bearing. "Cushioned" starts and stops—thanks to big, generous brakes and clutches—lengthen rope life and protect tractors and equipment. Rope life is further safeguarded by large-diameter, properly aligned sheaves and a long lead angle to assure smooth reeving on the drum. Swinging fairlead sheaves stay properly aligned with the lead cable even on short turns. Full details of the new Bucyrus-Erie single and two-drum winches are given in the completely illustrated bulletin PCU-1 recently issued by the company. Copies of the bulletin may be obtained by writing to Bucyrus-Erie Co., South Milwaukee, Wis.

New Lubrication Barrel Pumps for Contractors

New lubrication barrel pumps especially designed for heavy duty usage by contractors, and in fleet garages and motor bus maintenance shops, have been announced by the Alemite division, Stewart-Warner Corporation.



Model 6701 Heavy Duty Pump

One type, a volume barrel pump for 400-lb. oil drums (models Nos. 6701, 6702 and 6705), operates with a 40-to-1 piston delivering up to 6 lb. of regular semi-solid lubricant per minute. When equipped with a seven-to-one piston this pump can deliver up to 15 lb. of lubricant per minute for medium and smaller setups where requirements are less severe. Alemite standard and master grease pumps are designed for use directly on lubricant drums. Model numbers are: Standard, No. 7295, and Master, No. 7300. In both high and low pressure models these two pumps are equipped to fit both 100-lb. and 400-lb. oil drums. Even more sensational in its performance is the new Alemite air operated motor oil pump (Model No. 7710), a heavy duty volume pump fully capable of delivering 5 gal. of S.A.E. 10 oil per minute and 3 gal. of S.A.E. 60 per minute. This pump is adjusted to fit directly on the original 55-gal. oil drum. It is equipped with Alemite's new and improved Aldura air valve. All the Alemite heavy duty volume pumps are equipped with an additional Alemite feature—the Dynamatic Primer—enabling pumps to handle heavy fibrous lubricants with ease. All pump castings are of fine grain cast iron of high tensile strength. Wearing surface of the cylinder is hard chrome-plated over cast iron, assuring lasting service.

New Motorized Portable Patch Roller

A new motorized portable patch roller—the Trail-O-Roller Model No. 155—has been developed by Littleford Bros., 454 E. Pearl St., Cincinnati, O. This new model is designed to have the operator seated while the roller is in operation. All controls are at the operator's finger tips. Features of the Trail-O-Roller are: (1) The ease of converting from trailing to rolling position; an unique hydraulic arrangement raises and lowers the roller with ease, no back breaking jacking up or lifting. (2) Heavy duty clutch especially designed to stand hard usage. (3) Automobile type steering control for easy control of front roller. (4) Split front 18-in. dia. front roller for easier steering. (5) Removable



New Model 155 Trail-O-Roller



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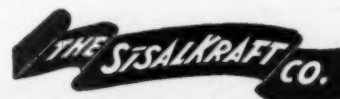
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wheels and stub axles for rolling up to poles, walls, or curbs. The Littleford Model No. 155 Trail-O-Roller will trail behind any truck at any speed; to change to the rolling position requires about two minutes time. Trail-O-Roller is designed for rolling patches, shoulder widening, clay sub-bases, parking areas, airport runways, alley paving, etc. For literature on the New Littleford Model 155 Trail-O-Roller, write Littleford Bros., 454 E. Pearl St., Cincinnati, O.

New 21-Cu. Yd. Self-Powered Earth Hauler

A new and larger self-powered earth hauler has been added to the line of The Euclid Road Machinery Co., Cleveland, O.



New Model Bottom Dump Euclid

This is the model 5LDT-71W Bottom-Dump Euclid with a struck measure capacity of 21 cu. yd. Other Euclids of this type have struck measure capacities of 9, 13, and 18 cu. yd. The 5LDT-71W Euclid has a heap load capacity at a 2:1 slope of 26.5 cu. yd.; it is designed and constructed

throughout to carry a payload of 60,000 lb. Powered with a Cummins diesel 200 HP. supercharged HBS-600 engine this Euclid is equipped with a Fuller model 284 fluid coupling, Lipe Z-38-S double 15 in. clutch, and Fuller model 8-B-860 transmission. It has eight speeds forward ranging from 2.1 to 23.3 m.p.h. at governed engine speed with full payload and two reverse speeds. The drive axle assembly is the Euclid model 8RA with a 3.15:1 ratio differential and 8.14:1 ratio planetary gearing, giving a overall reduction of 25.7:1. This axle assembly is of the full-floating type: the drive wheels ride on large tapered roller bearings mounted on a 7 in. spindle and are connected to the 4 in. drive axles by means of splined hub caps. Optional gear ratios are available where higher speeds are practical. Standard tire equipment includes 12.00 x 24, 14 ply truck-bus front tires and 24.00 x 32, 24 ply traction tread tires on the drive and trailer wheels. The trailer hopper is of the unique Euclid wedge-shaped design and construction. It is wider, higher, and deeper in front so that the center of gravity of the loaded unit is moved forward and downward. This distributes the load on the drive and trailer tires more evenly thus increasing stability and traction. The steep smooth sides and unobstructed full length and width door opening permit quicker dumping. Bottom-Dump Euclids pull off the dumped load easily because the hopper bottom slopes downward to the front making more clearance at rear, and the space between the opened doors is the same front and rear so as to eliminate the tendency to drag or form a bottle-neck at rear of dumped windrow. The 5LDT-71W Euclid is equipped with Bendix-Westinghouse air brake power and control equipment. The 26 in. x 6½ in. brake shoe assemblies on the drive and trailer-axles are air powered and controlled: opening or closing of the bottom doors is operated by air power mechanism and the exclusive Euclid patented "Wheel Wind," with a control valve on the steering column.

Parmanco

HORIZONTAL DRILLS



Stop . . . AND THINK!

Parmanco Drills have convinced owners of their true value—

In the Coal field, the Iron range, the Utility and the Contracting field.

We build a model for every need.

Parmanco Drills are now in their fourth year of successful operations.

WRITE US YOUR DRILLING PROBLEMS

PARIS MANUFACTURING CO., INC.

PARIS, ILLINOIS

New Line of Portable Air Compressors

A new line of portable air compressors stated to provide features never available before in a portable, has been introduced by Ingersoll-Rand Co., 11 Broadway, New York. These new machines carry a new trade name "Mobil-Air." The K-series Mobil-Air units are equipped with engines convertible from gasoline to oil or from oil to gasoline operation by making a simple substitution of fuel accessories and without changing heads or pistons. This engine is the Waukesha Multi-Fuel engine

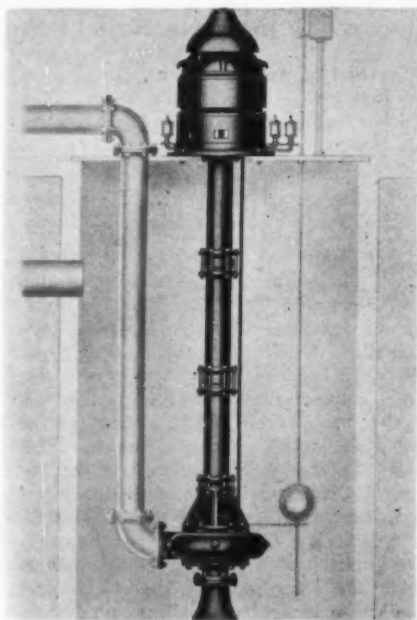


Mobil-Air Unit with Spring Mounting and Automotive Steering

built to Ingersoll-Rand specifications. On gasoline it operates as a new type high-economy engine and employs the same high-turbulence combustion chamber used in the Type H oil engine. On fuel oil, the engine operates like the familiar easy-starting, low-compression Hesselman type. Another outstanding Mobil-Air feature is the patented Drill-More multi-speed regulator which automatically adjusts the engine speed to the use of air and practically eliminates wasteful idling while air is being used. This device automatically selects the slowest and most efficient of three working speeds to deliver the required capacity.

New Sump and Bilge Pumps

A new line of centrifugal pumps specifically designed for intermittent-duty sump or bilge pumping, wet-pit, or submerged service has been announced by Fairbanks, Morse & Co., 600 S. Michigan Ave., Chicago. Known as Fairbanks-Morse 5410SS submerged suspended sump and bilge pumps, the products are the most modern modification of the famous A. B. Wood design. Designed for such typical industrial or municipal installations as disposal of surface or storm water or drainage of deep basements or underpasses, the pumps are available in 2, 3, 4, and 5-inch sizes for capacities up to 1400 g.p.m. for heads up to 120 ft. and settings up to 25 ft. The pumps in the larger discharge sizes handle solids up to 3-in. in diameter without difficulty. Installation of the new F-M 5410SS pumps is simple and inexpensive. No dry, watertight pump pit is required, for the pump is designed for suspension from the floor level into a sump or bilge. Multiple pump units may be suspended in one sump, where large variation in flow requires reserve pumping capacity. Construction features of this new line include a basic pump design developed around the



Cross Section of a Typical Sump Illustrating a Single Pump Unit, Pump Discharge Piping, Inlet Pipe, Wet Pit, Float Mechanism and Float Switch

well-known Fairbanks-Morse non-clog trash pump so successfully used since 1923 in municipal and sanitary sewage service; enclosed impeller with two well-rounded veins; motors of vertical, hollow-shaft, waterproof construction which employs the exclusive F-M copperspun rotor; high torsional-strength special steel shaft developed as a result of extensive Fairbanks-Morse experience in the deep well turbine and propeller pump field; cast-iron volute free from wearing rings such as used in water pumps; discharge openings that can be placed readily in any one of eight positions; and corrosion-resisting closure cover and closure seal which replace the stuffing box and adequately protect cast-bronze pump bearings.

New Heavy Gauge Road Form

Increased rigidity and greater accuracy of alignment are advantages claimed for the new DeLuxe road forms of the Jaeger Machine Co., 223 Dublin Ave., Columbus, O. Made of special carbon steel plate 7/32 in. thick, and with improved design triple braced stake pockets riveted at 5 points to base-face-top of form, these heavy duty road forms are built to hold true to line and grade and resist distortion under modern heavy duty, high speed spreading and finishing equipment. Although far huskier and stronger throughout, a 9 in. by 8 in. section weighs but 21 lb. more than ordinary 3/16 in. forms. Other advanced features include: joint plate, com-

One of thirty-six Baker Bulldozers rushing a big mid-western defense job to completion. It's pushing dirt up a bank so a shovel can load it into wagons.



HYDRAULIC SCRAPERS

Three easy loading models—3, 5 and 6 cu. yd. capacities for any tractor.



ROTARY SCRAPERS

Automatic, full revolving—in 5, 6 and 7 foot sizes for any tractor.



ROAD ROOTERS

5 tooth, with 5 ft. cut. Built in two models for tractors up to 50 H.P.



There's no time to wait for the breaks these days. You don't have to—with Bakers. Baker Bulldozers and Graders, along with other Baker Equipment, handle jobs as they come—no matter how tough they are. Baker products are sturdy descendants of pioneers in the earth moving field and are built to take it.

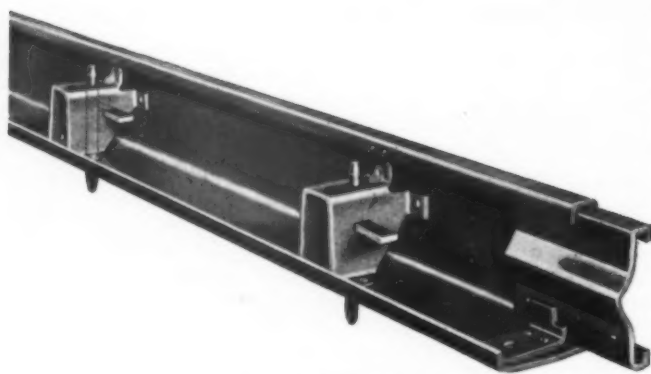
Give your tractors full cooperation by installing dependable Baker Equipment for bulldozing, grading, stripping, road building and every phase of regular and defense construction.

Ask for Bulletins on
Any Baker Product.

THE BAKER MFG. CO.
506 Stanford Ave.
SPRINGFIELD, ILLINOIS

BAKER
TRACTOR EQUIPMENT

BULLDOZERS, GRADEBUILDERS
ROAD ROOTERS, SCRAPERS
ROAD DISCS, MAINTAINERS
SNOW MOVING EQUIPMENT



New Jaeger Deluxe Road Forms

pletely telescoped with both top rail and base guide insures perfect alignment, maximum rigidity of lock, and provides support for outside edge of top rail. Lock plate extends 3 in. from face of form for easier hammering when locking or unlocking; eliminates 90 per cent of breakage. Chamfered ends facilitate setting of

curves. Jaeger 'Duo-Rails,' for centering load when needed, fit this standard form.

New Wagon Drill and New Portable Compressor

A new wagon drill and a new small moderate priced portable compressor have been put on the market by Sullivan Machinery Co., Michigan City, Ind. The Sullivan wagon drill mounts 55 to 75 lb. hand rock drills and increases drilling footage 50 to 80 percent over hand operation. It is pneumatic tired, convenient to handle and drills at any angle. An independent air motor operating the feed gives wide range of pressures with ample power for pulling steels. Wagon drills are built in light, medium and heavy weight models with 4 ft., 6 ft. and 10 ft. steel changes. The Sullivan Zephair compressor is a compact, quality built unit. The two wheel pneumatic tired model tows conveniently behind a passenger auto at regular traffic speeds. It is built for one-man handling and can be operated by the drill runner. The skid type can be set in a pick-up truck, leaving ample room for drills and other equipment. The Zephair compressor is built in 105, 85 and 60 C.F.M. It is air cooled, single stage, with streamlined air passages, full force feed lubrication, life time main bearings and electric starter.

New 97 H.P. Engine

A new 97 HP. engine, offered as standard equipment in all 2-ton GMC Trucks, and also available at slight additional cost in GMC 1-1/2-ton models, has been announced by General Motors Truck & Coach Co. The new engine has a displacement of 236 cu. in., developing 97 HP. at 3,200 r.p.m., and 192.5 lbs. ft. torque at 1,000 r.p.m. The high torque of this latest "super duty" engine to join the ranks of GMC's valve-in-head engine line has been attained through development of a high-lift cam—with properly coordinated engine timing—which permits a more complete utilization of the high power and economy advantages claimed as inherent in GMC Turbo-Top piston and combustion chamber design.

New Truck Mixer

A new truck mixer, designed for a higher point of discharge and stated to differ in several fundamentals from present designs, has been placed on the market by the Ransome Concrete Machinery Co., Dunellen, N. J. According to Ransome, the drum rollers of this "Hi-Up" mixer are positioned under the center of gravity of the drum practically balancing the load and relieving the strain on the front pedestal bearing. This provides the machined drum track around the center of the drum which is stated to tend to act as a reinforcing band where the impact of the intake load is the heaviest and to eliminate the long span of light steel drum shell. Accessibility to all operating parts is claimed by the manufacturer. Because there are no drum rollers at the discharge end of the mixer the mixer frame is shorter. Also because there are no supporting members ordinarily required for



BITUVIA ROAD TAR—Because of construction and maintenance economies and because of its traffic safety BITUVIA road tar construction offers distinct advantages to the contractor and to the public. Deep penetration holds the aggregate firmly for long service. BITUVIA is easily applied. It is highly resilient and skid-resistant. Made in seven types to meet any Federal, State, County or Municipal specifications.



PLASTUVIA CRACK FILLER

The unusual ability of this filler to withstand a wide range of temperatures—from bitter cold to torrid heat—without flow or traffic "pull" in summer, or chipping in winter, makes it an outstanding product. The ease with which it is applied, and the manner in which it holds tenaciously to concrete and brick surfaces characterize this material. Your inquiry will bring you further information about these products.

REILLY TAR & CHEMICAL CORPORATION

Executive Offices: Merchants Bank Building, Indianapolis, Indiana
2512 S. DAMEN AVENUE, CHICAGO, ILLINOIS 300 FIFTH AVENUE, NEW YORK, N. Y. ST. LOUIS PARK, MINNEAPOLIS, MINN.
FIFTEEN PLANTS TO SERVE YOU

the drum rollers at the discharge end of the mixer the "Hi-Up" may be backed closer to forms and discharged without the use of the chute although a two-piece chute is standard equipment. The "Hi-Up" is designed for combination top or end loading.

WITH THE MANUFACTURERS

Frank Gause Is Dead

Frank Gause, Secretary of The Four Wheel Drive Auto since the forming of the corporation in 1910, died April 2, of a cerebral hemorrhage.



Frank Gause

Mr. Gause was born at Lake Mills in Jefferson County, Wisconsin, on Feb. 6, 1870. He studied telegraphy and came to Clintonville, Wis., in 1890 as an operator in the depot for the Chicago & Northwestern R. R. In 1892 he married Stella Pearl Stimson of New London, Wis., who is left to mourn his sudden death. On July 14, 1910, Mr. Gause was elected secretary of The Four Wheel Drive Auto Co. and he served as secretary without pay for a year. As the secretarial work increased, an allowance of \$15 a month was granted him until June 1912, when he resigned from his railroad position to devote his full time to the secretarial work of the corporation, starting with a salary of \$75 per month. Mr. Gause grew up with his job, a position of trust and responsibility which he handled with unquestioned efficiency. He served the community for 17 years as city clerk and was a director of the former Clintonville State Bank, and the former First National Bank of Clintonville. He was Dean of the Clintonville Masonic Chapter and Commandery. He perhaps conferred more Masonic Master degrees than any other man in the state. Mr. Gause was a 32nd degree Mason, a Knights Templar, a member of the Shrine, a Past Master of the Blue Lodge, Past Commander of the Commandery, and a Trustee of the Masonic Lodge since its organization in Clintonville.

Dow & Company, Inc. Appointed Bucyrus-Erie Distributors

Dow & Company of Buffalo, N. Y., have been appointed distributors for Bucyrus-Erie 3/4-yd. to 2 1/2-yd. shovels, draglines, clamshell and lifting cranes. They will cover an extensive territory in Northwestern New York including the counties of Alleghany, Cattaraugus, Chautauqua, Chemung, Erie, Genesee, Livingston, Monroe, Niagara, Orleans, Schuyler, Steuben and Wyoming. Cooperating with Dow & Company will be the Bucyrus-Erie eastern district office, 30 Rockefeller Plaza, New York City.

The Brooks LOAD LUGGER

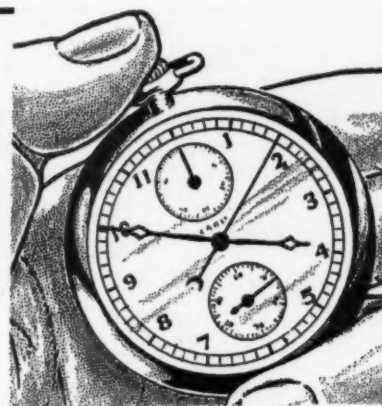
... is the fastest method of moving materials that are loaded by hand ... say scores of engineers and road builders who have seen this multiple-bucket type dump-truck unit in action.

Equip one truck with a Load Lugger and use 5 or 10 buckets on each job ... then you will have an outfit equal to several ordinary trucks in daily yardage capacity.

You can prove it to your own satisfaction by taking advantage of our Special Introductory Offer. Ask for details.



Distributors in all
Principal Cities



Only about 15 SECONDS for picking up bucket or dumping the load

KNOXVILLE

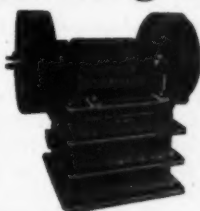
TENNESSEE

505 Davenport Road

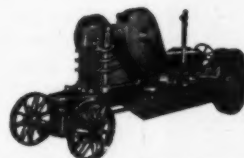
Brooks

EQUIPMENT AND MFG. CO.

Serving America in Road Construction



All cast steel Roller Bearing JAW CRUSHER.



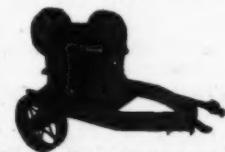
Self Traveling Maintenance Tractor-Power Jaw Crusher



Portable Two-in-One Adjustable Hammer Crusher



Cross Section View of Pulverizer HAMMER CRUSHERS from 1 ton per hour to 500 tons of Rock per hour capacity.



Trailer Type Maintenance JAW CRUSHER with Universal Drive.

GRUENDLER'S Long Experience—Sturdy Construction has been proved Best by Test on Difficult Work,—with Greater Profits to Users.

See the Gruendler Crushing Equipment at work, then you will understand why they were selected above other types. Gruendler's Sturdy Construction—Ease of Operation—Large Capacities and Minimum Power Requirements will help you to take care of road jobs on schedule time—meeting exact specifications. Write for proof.

GRUENDLER

We Will Send You Illustrated Catalog Free On Request

GRUENDLER CRUSHER & PULVERIZER CO.
2915-21 N. Market St., St. Louis, Mo.

"56 Years Building Better Crushers"



**32 Miles of
MONOTUBES**

PRODUCE FOUNDATION
FOR NATIONAL GALLERY
OF ART

A gift to the American people by the late Andrew W. Mellon, the National Gallery of Art, Washington, D. C., was officially opened and accepted for the nation by President Roosevelt on March 17. It will serve as a permanent home for the Mellon and Kress collection of world famous paintings and art objects.

Supporting the foundation of this building are approximately 7000 Monotubes, representing 32 miles of piling. All of these steel casings were driven to 35-ton bearing and filled with concrete in less than the specified 90-day period.

Installation of cast-in-place concrete piles by the Monotube Method offers the same time and money-saving advantages to small and large jobs alike. These cold rolled steel casings reduce handling time and driving costs to a minimum because they are light in weight and can be driven without a mandrel by a crawler crane equipped with standard leads and hammer. Monotubes are inspected easily after driving and are available in a gauge, taper and length to meet all soil conditions. Write for copy of Catalog No. 68A.

**THE UNION METAL
MANUFACTURING CO.**
CANTON, OHIO

Charles S. Thomson Dies in Brazil

Charles S. Thomson, 56, Export Manager of The Four Wheel Drive Auto Co., Clintonville, Wis., for the past 23 years died suddenly April 5, in Rio De Janeiro, Brazil. Mr. Thomson was born in the Argentine on June 24, 1885, of Scotch missionary parents, and received his elementary education in Spanish and English. He was sent to the United States as a government student by the Republic of Argentina and attended the Ohio State University and was graduated from the University of Illinois. After graduation, he returned to South America, but returned to the United States to accept a position with the export department of the Montgomery-Ward Co. in Chicago where he met his future wife, Amanda Chamberland. He joined the FWD organization on Jan. 2, 1918, as export manager and travelled extensively for the company in Europe and South America, making more than 50 ocean crossings. He could speak fluently in eight foreign languages and could carry on written correspondence in five languages. He had one of the most successful sales records in the company's history. On his last trip to South America which was in September of last year, he took his son James, 18, with him, who was with his father up to a month ago when he returned to Clintonville from Brazil to work at the FWD plant. Mr. Thomson is survived by his son James and a brother Edward in Cincinnati and two brothers and two sisters in Buenos Aires, Argentina.

Mr. Thomson was a member of the St. Rose Catholic Church in Clintonville, and sang in the choir. He was a charter member and past Grand Knight of the Clintonville Council of the Knights of Columbus. His body was returned to Clintonville for interment in St. Rose cemetery. Mrs. Thomson died three years ago.

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Lincoln Electric Appoints Welding Consultant at Washington

The Lincoln Electric Co., Cleveland, O., has appointed B. J. Brugge as its welding consultant and engineer at Washington, D. C. He will be engaged in consulting work having to do with the application of arc welding in the National Defense Program and will be available for such work with all governmental departments. He will be associated with T. A. Canty, Inc., Lincoln representative in Baltimore, Md.

Koppers Consolidates Chicago Office

The Chicago offices of The Koppers Coal Co. and the Bartlett Hayward and Wood Preserving divisions of Koppers Co. will be consolidated about May 1, it is announced by Walter Rothenhoefer, general manager of sales for the coal company. The new offices are being located in the Railway Exchange Bldg., 224 South Michigan Ave.

A BURCH ON THE JOB



A BURCH FORCE FEED SPREADER

on the job will insure an even, uniform stone mat. Specially designed cylinder will eliminate corrugating, dual feed gate control gives a wide range of adjustment to the flow of material. The machine is operated by the movement of the truck forward or backward.

Manufactured by

**The
BURCH CORPORATION**
Crestline, Ohio

Builders of equipment for Fifty Years

"ALL OUT FOR DEFENSE"

OF OUR CITIZENS AGAINST
TRAFFIC ACCIDENTS WITH

**CATAPHOTE REFLECTOR—
BEACONS
STOP SIGNS
GUIDE SIGNS
NITEWAY OUTLINERS
LANE AND CURB MARKERS**

AND BRING

"TOTAL VICTORY"

Cataphote Reflector Buttons are guaranteed for 3 years against loss of brilliance. Fused aluminum reflector surface positively eliminates all air space. Reflecting angularity up to 44 degrees.

Send us your requirements of Plain and Reflector Signs. Let us prove that Cataphote signs are better.

WESTERN CATAPHOTE CORP.
TOLEDO, OHIO

New Cutler-Hammer Service for Boston Area

Cutler-Hammer, Inc., Milwaukee, Wis., pioneer manufacturers of electric control equipment, has established a warehouse at 131 Clarendon St., Boston, Mass. A complete, up-to-the-minute stock of the company's products will be carried for immediate delivery. W. E. Addicks is district manager in charge of the Boston territory. The company's Boston sales office has been moved to new and larger quarters adjoining the warehouse at 131 Clarendon St.

Ralph Hoffman Elected Vice-President Link-Belt Co.

Alfred Kauffmann, Link-Belt Co. president, announces that with a view to making the General Office organization a more



effective aid to plant sales managers, the board of directors has elected Ralph M. Hoffman a vice-president, delegating to him the general direction and supervision of sales for the company. Mr. Hoffman, a mechanical engineer, Uni-

versity of Minnesota, 1911, has been assistant to the president since January, 1940, with headquarters at 307 North Michigan Ave., Chicago, where he will continue to have his office. He came to the Link-Belt organization in 1923 as manager of Link-Belt Meese & Gottfried Co.'s Seattle branch. He served in this capacity until 1931, the name of the Pacific Coast subsidiary meanwhile becoming Link-Belt Company Pacific Division; and from 1931 to 1939 served as vice-president and sales manager of this subsidiary, with headquarters at San Francisco. Mr. Hoffman's previous experience consisted of: 1911-12, apprentice machinist, Smith Cannery Machines Co., Seattle; 1912, draftsman, Superior Portland Cement Co., Concrete, Wash.; 1913-15, branch manager, Meese & Gottfried Co., Vancouver, B. C.; 1916, sales engineer, Meese & Gottfried Co., Seattle; 1917-21, vice-president, Hesse-Martin Iron Works, Portland, Ore.; 1921-23, manager Seattle branch, Meese & Gottfried Co.

LeTourneau Promotions

R. G. LeTourneau, Inc., Peoria, Ill., announces the appointment of Walter L. Schump to its advertising staff. Mr. Schump takes over the duties of former assistant advertising manager, A. Robert Thomson, who has been promoted to the training division of the sales department. For the past five years Mr. Schump has been associated with The Denver Equipment Co. and The Mine & Smelter Supply Co. in charge of export sales and export sales promotion. At LeTourneau, he will handle direct mail and export advertising. Other changes in the department promote Paul R. Miller to national copy. Mr. Miller's News Bureau activities have been taken over by Eugene E. Weyeneth.

Wood Roadmixer Co. Increases Manufacturing Facilities

The Wood Roadmixer Co., manufacturers of mixing plant for contracting asphaltic mats and stabilized bases has increased its manufacturing facilities and hereafter will sell its roadmixer direct to contractors and engineers. Heretofore all roadmixers have been operated entirely on a rental basis. Offices of the company are located in Los Angeles, Calif., 208 West 8th St., and the factory is located at 6900 Tujunga Ave., in North Hollywood.

S. H. Sanford Named Secretary FWD

S. H. Sanford, Manager of FWD western sales division, was named secretary of The Four Wheel Drive Auto Co. by the board of directors to succeed Mr. Frank Gause, who recently passed away. Mr. Sanford has a record of 21 years with FWD and is well known to the organization. He was in charge of the dealer division of the sales division. This responsible position is in recognition of the thoroughness that always characterizes Mr. Sanford's work. Mr. Sanford is a member of the American Legion and the Masonic Order, and is also a member of the Executive Board of the Valley Council of Boy Scouts of America.

Billings Branch J. D. Adams Company Appointed Bucyrus-Erie Distributors

J. D. Adams Company of Billings, Montana, have been appointed distributors for Bucyrus-Erie $\frac{3}{4}$ -yd. to $2\frac{1}{2}$ -yd. shovels, draglines, clamshell and lifting cranes and Bucyrus-Ruth excavators. Their territory includes all of Montana east of the Rockies and eight counties in Northern Wyoming.

Chain Belt Appoints Johnson Equipment Corp. as Distributors

Chain Belt Co. of Milwaukee, Wis., has appointed Johnston Equipment Corporation, 1204-6-8 Fifth St., Sioux City, Ia., as its exclusive distributor of Rex construction equipment in the Sioux City area. Wagner M. Johnston, President, has been identified with the construction machinery industry for a number of years. The Rex line of construction equipment that will be handled by the Johnston Equipment Corporation consists of Rex mixers, Rex speed-prime centrifugal pumps, Rex pavers, Rex Pumpcrete, Rex moto-mixers, Rex mortar and plaster mixers.

Howard-Cooper Now Distributor for Combined Link-Belt Speeder Shovel Line

Link-Belt Speeder Corporation, 301 West Pershing Road, Chicago, has announced the appointment of Howard-Cooper Corp., Portland, Seattle and Spokane, as distributor for the combined line of Link-Belt Speeder shovels, draglines, cranes. These range from fast, mobile $\frac{3}{4}$ -yd. units to 3-yd. heavy-duty machines. The Howard-Cooper organization, of which Les Gardner is head, has for many years handled the $\frac{3}{4}$ -to-1-yd. Speeder line of crawler and truck mounted machines. The larger

WELDED

**ROLLED STEEL
CONSTRUCTION
for GREATER
STRENGTH
and SPEED**

**"NOW WE'RE ALL HAPPY!
— THE BOSS BOUGHT A
NEW WILLIAMS BUCKET"**



"I have been operating cranes for 10 years," writes A. G. Grupe, veteran crane operator for the Edison Fuel and Materials Co., Chicago, "and have never used a better bucket. The boss always has a big smile when he sees me come up with material spilling over the sides."

Operators and bosses all prefer Williams. Williams Welded Construction means longer wear . . . less breakage; faster work . . . more yardage! Williams buckets operate year in and year out with practically no cost for maintenance and repairs.

Prompt delivery and service through nation-wide distributors. Write for Free Bulletins on any of the 11 types of Williams buckets.

THE WELLMAN ENGINEERING CO.
7003 Central Ave. Cleveland, Ohio

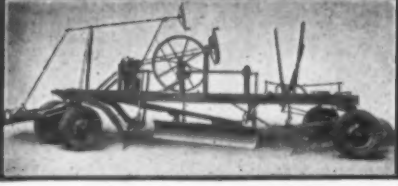
WILLIAMS
Buckets
built by WELLMAN

SNOW GO
 ELIMINATES dangerous one way bottlenecks. Reduces expensive repeat plowing. Reduces snow damage to roads, and cuts resulting road repair. Plan now for real snow removal next winter.

Klauer Manufacturing Co.
 IOWA
 DUBUQUE



MASTER WORKMAN



For Better Roads, put a WORKMAN Machine on the job. 3 sizes: THE GENERAL • THE SUPER THE MASTER

YORK MODERN CORPORATION
 UNADILLA, NEW YORK

CLEARING HOUSE

EQUIPMENT FOR SALE OR RENT

- 1—completely rebuilt 10 ton, three wheel AUSTIN Autocrat Roller, excellent condition.
- 1—CLETRAC rebuilt front end loader, crawler type.
- 1—315 LeRoi two stage compressor.
- 1—315 SCHRAMM two stage compressor
- 1—210 SCHRAMM gas compressor
- 1—210 SCHRAMM diesel compressor
- 3—60 LeRoi compressors.
- 1—4" CARTER Centrifugal pump.
- 1—3" CARTER Centrifugal pump.
- 3—3" CARTER Single Diaphragm Pumps
- 2—2" CARTER Centrifugal pumps.
- 1—AUSTIN 12 foot Motor Grader.
- 1—ADAMS 10 foot Motor Grader.

CHICAGO CONSTRUCTION EQUIPMENT CO.
 8039-41 Halsted St. S.
 Chicago, Illinois Radcliff 5800

FOR SALE

20 ton Hvass Trailer. Slightly used. Six wheels and equipped with solid tires. Bargain.

W. W. SANDERS
 Warrenton, Virginia

machines now added to the line include Link-Belt Speeder crawler-mounted units equipped with Speed-o-Matic hydraulic power control. Horace Niles, recently announced as Link-Belt Speeder district representative, makes his headquarters at the Howard-Cooper Portland office.

Le Tourneau Purchases Avery Farm Machinery Plant

R. G. LeTourneau, Inc., Peoria, Ill., manufacturers of heavy grading equipment, has purchased the Avery Farm Machinery Co. plant, located adjacent to the present LeTourneau factory in Peoria. The sale includes all of the buildings and equipment of the Avery company with the exception of two buildings which were previously sold. The property has a frontage of 1300 ft. and will add 282,000 sq. ft. of floor space to the present LeTourneau plant. Work of moving into the newly purchased plant was started immediately and will continue at rapid pace to enable LeTourneau to speed up production of earthmoving equipment. The new quarters will house the production lines for the manufacture of the Tournapull, newest LeTourneau innovation in high-speed earthmoving and of the power control units which supply the power for all LeTourneau machines. The moving of these two production lines should do much to relieve the congestion of the present plant.

Carl Stieger Named Director FWD

Carl Stieger, prominent Wisconsin industrialist, has been named director of The Four Wheel Drive Auto Co. by the board of directors. Mr. Stieger is president of the Deltex Rug Co. of Oshkosh, Wis., the largest fiber rug manufacturers in the world. He is also president of the Oshkosh Pure Ice Co. and vice president of the Neidhoefer Co. of Milwaukee, a wholesale floor covering firm. A civic leader, he has been a director of the Oshkosh Chamber of Commerce and at present is president of the Oshkosh Community Chest. Mr. Stieger's father, the late Emil Stieger, was one of the original stockholders in the FWD, having substantial holdings in the company. Carl Stieger has shown a keen interest in the company and he brings to the FWD organization years of successful experience in manufacturing selling and management.

NEW TRADE LITERATURE

Slackline Cableway Excavators—A new 24-page booklet has just been issued by Sauerman Bros., 488 South Clinton St., Chicago, Ill. In it the operating principles of the slackline cableway excavator are explained and the field of usefulness of this machine is defined. Following this general information, the specifications of the several different size groups of Sauerman machines are set forth with illustrations and descriptions of every important mechanical detail. The various applications of the equipment then are illustrated by means of photographs of typical installations. Among the uses thus illustrated are: Sand and gravel excavation in pits and rivers, earth dam construction, reservoir excavation, deepening rivers, cleaning settling

CLEARING HOUSE

USED EQUIPMENT IMMEDIATE DELIVERY

	Condition
1—9" x 16" bronze bearing DIAMOND jaw crusher complete with flywheels and Model P287D2 LeRoi motor mounted on trailer unit with steel wheels.....	New
2—Pitman assemblies with S.K.F. bearings including main bearings for 10" x 20" jaw crusher.....	New
1—15" x 36" roller bearing DIAMOND jaw crusher.....	New
1—15" x 36" Pitman assembly—new design with 8" shaft, including main bearings.....	New
1—Bucket elevator 32'0" centers, rigid type, with buckets 12" x 6" x 7 1/2" mounted on belt.....	New
*6—Pitman assemblies for 10" x 20" jaw crusher, bearings S.K.F. type.....	Slightly Used
*1—Pitman assembly for 10" x 20" jaw crusher, bearings Timken type.....	Rebuilt
1—10" x 20" roller bearing DIAMOND jaw crusher equipped with Timken bearings.....	Rebuilt
*3—10" x 36" Pitman assemblies for 10" x 36" jaw crusher.....	Rebuilt
*1—15" x 36" Pitman assembly complete.....	Rebuilt
1—20'0" bucket elevator with buckets 10" x 6" x 7 1/2" mounted on chain.....	Rebuilt
1—30" x 10'0" double shaker screen.....	Slightly Used
1—Grizzly and hopper 6'8" x 6'8"—with 8" sq. openings and 20"x3'0" plate feeder.....	Condition
2—Quarry plants with 10" x 20" anti-friction bearing jaw crushers and bucket elevators, mounted on trucks with four steel wheels.....	New
2—30 cubic yard bins, 3-compartment, no jack legs.....	New
1—No. 25 hog, anti-friction bearing type with cast steel discs.....	New
6—Steel wheels 40" dia. x 16" face to take 4" Hyatt bearings.....	New
4—Steel wheels 40" dia. x 10" face to take 4" Hyatt bearings.....	New
4—Steel wheels 28" dia. x 4" face, bore 1 1/2".....	New
10—Steel wheels 28" dia. x 5" face, bore 1-15/16".....	New
8—Steel wheels 24" dia. x 3 1/2" face, bore 1 1/2".....	New
4—Steel wheels 28" dia. x 14" face, bore 4" Hyatt.....	New
1—Allis-Chalmers motor, 25 H.P.....	Reconditioned
1—Allis-Chalmers motor, 60 H.P.....	Reconditioned

*The above Pitman assemblies can be installed in new bases and furnished as complete machines.

DIAMOND IRON WORKS, INC. AND MAHR MANUFACTURING CO. DIV.
 MINNEAPOLIS MINNESOTA

CHARLES EVAN FOWLER

M. INST. A.C.E. M. ENG. INST. CAN.
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 RIVERS—HARBORS—PORT WORKS
 "IDEALS OF ENGR. ARCHITECTURE"
 1120—S Av. S., Seattle 92 Liberty St. N.Y.C.

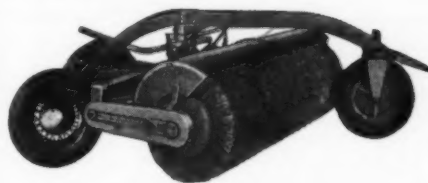
WANTED

Used Steam Shovel
 any Make

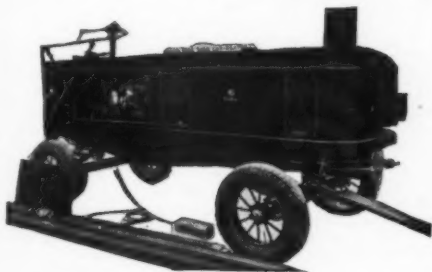
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ROADS AND STREETS
 is The Engineering Contracting Authority of the Highway Industry.

GRACE



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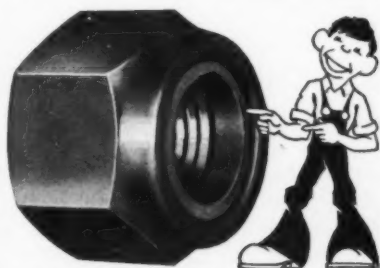


● *Grace 2-Way Axle Driven Sweeper*—the modern traction driven sweeper that successfully meets the sweeping problem of any contractor.

● *Rapid Fire Heater*—A fast-pumping, fast-heat circulating heater that heats 10,000-gallon insulated cars at 40-50° per hour. Write for information and prices.

W. E. GRACE MFG. CO. 6000 Holmes St. DALLAS

This SELF-LOCKING NUT



helps to keep road-building equipment on the job . . .

A lot of road-building equipment has its life shortened because vibration loosens bolted connections . . . thus opening the way to more vibration, excessive wear, and breakage.

You can guard against this danger by specifying Elastic Stop Nuts on new equipment, and by using these nuts for replacement.

All standard sizes are available . . . and they can be used over and over again.

» Write for folder explaining the Elastic Stop principle

ELASTIC STOP NUT CORPORATION
2357 VAUXHALL ROAD • UNION, NEW JERSEY

Elastic Stop SELF-LOCKING
NUTS

ponds, clay pit mining, placer mining, and many other long range material handling jobs.

Contractors' Almanac—A large wall calendar which is in reality an "Almanac" for contractors and builders doing concrete form work has been issued by the Richmond Screw Anchor Co., for free distribution to contractors and engineers. Arranged on the large single sheet which carries the three months at a glance calendar pad are a series of charts and tables giving the following information:

1. Practical concrete pouring suggestions.
2. Common form lumber data.
3. Handy wire nail facts; sizes, length, strength, etc.
4. Tables of decimals of a foot for each $\frac{1}{8}$ in. from $\frac{1}{8}$ in. to 12.
5. Table of weights and areas of reinforcing steel.
6. Concrete information on water-cement ratios.
7. Richmond Ty-Spacing chart giving complete information on ty-spacing, form lumber, concrete rise per hour, etc.

High Speed Diesel Lubrication—A well illustrated, 16 page booklet, explaining in readily understood terms the lubrication problems with today's high speed diesels, has been issued by Standard Oil Co. of New Jersey. Particular emphasis is placed on bearing problems and wear. Analysis of the roles played by various types of oils, and what conditions suggest the use of "heavy duty" oils are included.

Land Clearing, Earth Moving and Snow Removal Equipment—LaPlant-Choate Manufacturing Co., Inc., Cedar Rapids, Ia., has just issued five new circulars, each 16 pages in two colors. Form No. A-110-636 describes each of the products manufactured by the company. Sections are devoted to land clearing, earth moving, and snow removal equipment. Each product is illustrated and a short description of its uses included. Form No. A-111-637 describes the LaPlant-Choate hydraulic trailbuilder. It is profusely illustrated. Form No. A-112-648 describes the LaPlant-Choate hydraulic bulldozer. It also is profusely illustrated. Form No. A-113-639 is a booklet on the LaPlant-Choate hydraulic "Carrimor" scrapers, which range in size from 2.9 to 8.2 cu. yd. Photographs and complete details are given. Form No. A-115-641 is a circular on the LaPlant-Choate forced ejection "Carrimor" scrapers. These scrapers range in size from 12 to 33 cu. yd. heaped measure.

Contractors Air Powered Tools—A new catalog describing the complete line of Thor mining and contractors air-powered tools has been issued by the Independent Pneumatic Tool Co. It contains complete descriptions and specifications of all Thor rock drills, paving breakers, clay and trench diggers, sump pumps, saws and associated air tools. In addition, it graphically depicts specific applications and uses for all the various tools. Profusely illustrated and attractively printed in two colors, the new catalog also gives detailed information on accessories and equipment for use with the tools and points out important construction features.

There is something about "BERG" Equipment, which you don't get from other manufacturers.



"BERG" HI-WAY SURFACER—one-man outfit. Has Power Take-off and External Magneto, as illustrated. Used for surfacing roads.

"BERG" MODEL V2—AS VIBRATOR—Portable—Light Weight—Ideal for internal vibration.

"BERG" MODEL A SURFACER—suspended from operator's shoulder. Only machine so constructed. 110 or 220 voltage furnished.

"BERG" WATER FEED SURFACER—electric and gasoline.

"BERG" HEAVY-DUTY SURFACER—suspended between two wheels. Has Model A Tool Head complete with Cutter Plate and Carbo Disc.

Write for circulars—Dept. C

THE CONCRETE
SURFACING MACHINERY CO.
CINCINNATI, OHIO

Reliance—

CRUSHING
SCREENING and
WASHING UNITS

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Crushers	Bins	Drag-Lines
Elevators	Pulverisers	"GAYCO"
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Kingston, N. Y.

Canadian Representatives: F. H. Hopkins & Co., Ltd.
340 Canada Cement Co., Montreal, Que., Can.



SURFACE MARKERS For STREETS and HIGHWAYS

"The Eyes of the Road"

Suggestions for your problems, no obligation.

THE STAR-LITE CO., 312 E. MARKET ST., INDIANAPOLIS, IND.

*Quick-Acting is
only one of their
Strong Points!*



"AIR KING" HOSE COUPLING

Universal Type

A "twist of the wrist" is all it takes to connect this practical, efficient air hose coupling . . . the coupling with the patented safety locking device. Locking ends (heads) are identical for all sizes of hose and threaded ends, permitting coupling of any two sizes of hose within the "AIR KING" hose end range, or coupling to any pipe up to 1" by use of threaded connections. Style A K M—Malleable Iron, Cadmium Plated; Style A K B—Bronze.



"DIX-LOCK" AIR HOSE COUPLING

With Renewable Sleeve and Spring

A slight push, a quarter-turn, and the connection is made; and it can't come apart until sleeve is pulled back and coupling unlocked by a reverse quarter-turn. In addition, patented renewable sleeve and spring feature permits quick, easy removal and replacement of these parts, if necessary, without detaching coupling from hose. Made in brass or cadmium plated steel. Completely interchangeable.

*Carried in Stock by Leading
Rubber Manufacturers and Jobbers*

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